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SOCH
Simplified Ophthalmology
Conceptual Handbook

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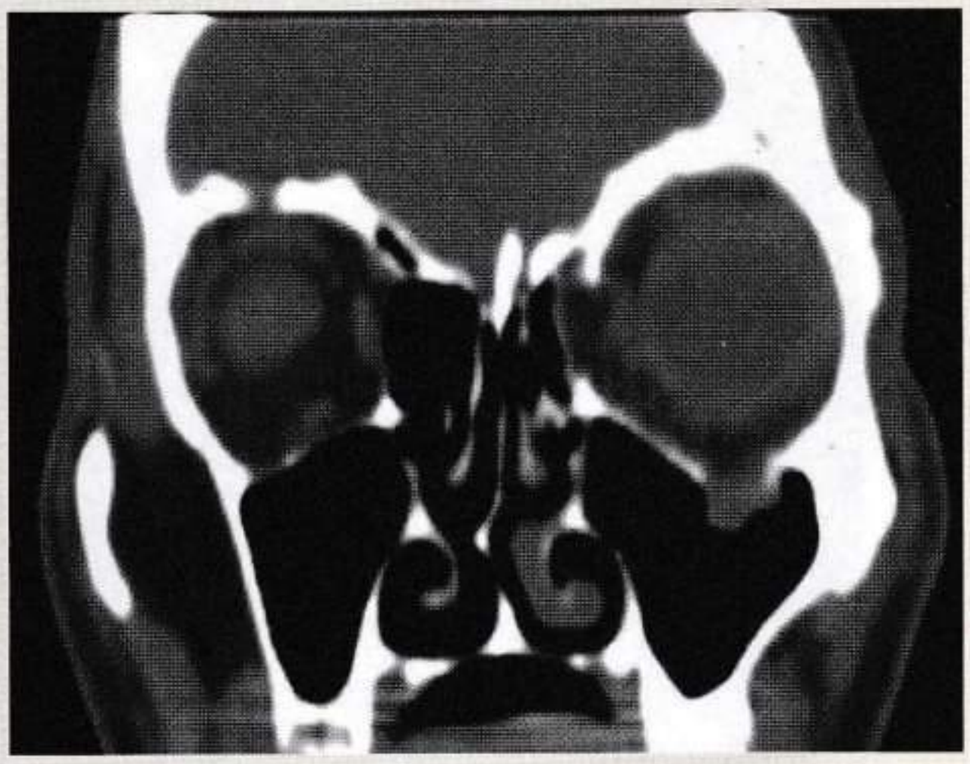
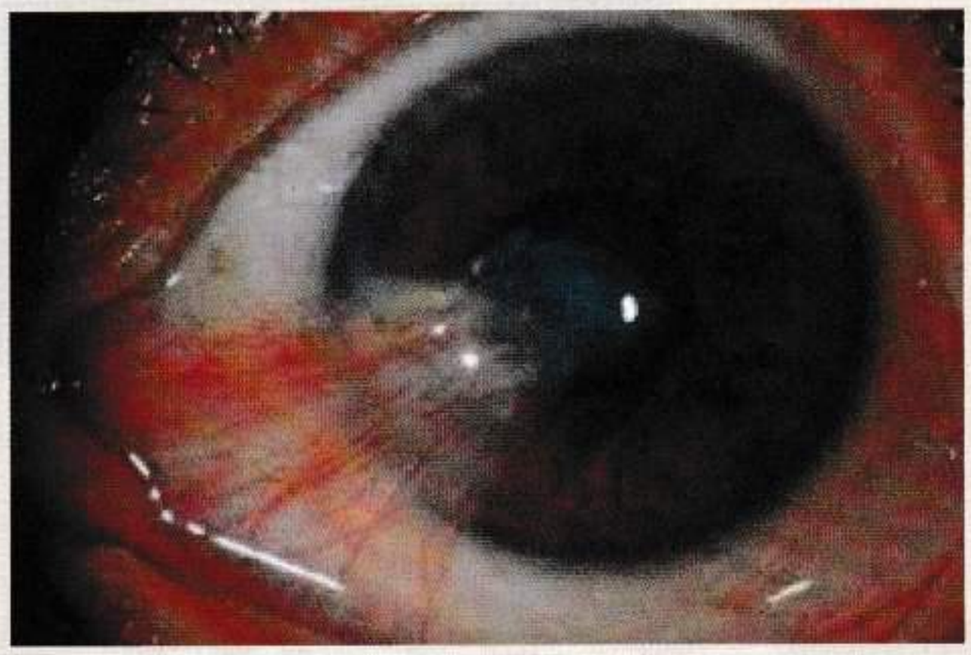
RECENT PATTERN QUESTIONS 2019 AT A GLANCE

RECENT PATTERN QUESTIONS 2019

1. **Against the rule astigmatism is corrected with:**
   a. –1.25 at 90 degree
   b. –2
   c. +2.5/+1.25 at 90 degree
   d. +0.25 at 90 degree
2. **Which of the following tests is being done in the image shown:**
   a. Cover test
   b. Prism bar cover test
   c. Occluder test
   d. Uncover Test
3. **Esotropia is associated with:**
   a. Myopia
   b. Hypermetropia
   c. Astigmatism
   d. Presbyopia
4. **Most common ocular sign of Myasthenia Gravis?**
   a. Ptosis
   b. Proptosis
   c. Diplopia
   d. Lagophthalmos
5. **Glaucoma valve implant is used in which of the following surgery?**
   a. Trabeculectomy
   b. Sclerotomy
   c. Laser photocoagulation
   d. Setons
6. **Which anti-glaucoma drug causes apnea in children?**
   a. Beta blockers
   b. Cholinergics
   c. Alpha 2 adrenergic agonists
   d. Carbonic anhydrase inhibitors
7. **Intravenous (I.V.) Mannitol is used in which of the following conditions:**
   a. CRAO
   b. Congestive heart Failure
   c. Angle closure glaucoma
   d. Pulmonary edema
8. **A patient came to the casualty with acute attack of asthma after starting treatment of glaucoma. The causative drug is:**
   a. Timolol
   b. Betaxolol
   c. Clonidine
   d. Acetazolamide
9. **Treatment of retinoblastoma is by:**
   a. 5FU + Cisplatin + Vinblastine
   b. Carboplatin + Etoposide + Vincristine
   c. Cyclophosphamide + Etoposide + Vincristine
   d. Cyclophosphamide + Doxorubicin + Etoposide
10. **Retinitis pigmentosa is associated with deficiency of:**
    a. Docosahexaenoic acid
    b. Eicosapentaenoic acid
    c. Arachidonic acid
    d. Thromboxane
11. **A 5-year-old boy presents with Severe ptosis associated with poor levator function. Which of the following will be the treatment?**
    a. Frontalis Suspension surgery
    b. Levator resection
    c. Mullerectomy
    d. Fasnella servat operation
12. **A patient presented with diplopia and restricted ocular movements. CT scan shows the image given below. What is the most probable cause?**



    a. Le-fort fracture
    b. Blow out fracture of orbit
    c. Zygomatic fracture
    d. Orbital rim fracture
13. **The condition seen below would cause maximum visual disturbance due to:**



    a. Cataract
    b. Astigmatism
    c. Visual axis enchroachment
    d. Glaucoma

Answers Keys

1. (a)	2. (a)	3. (b)	4. (c)	5. (d)	6. (c)	7. (c)	8. (a)	9. (b)
10. (a)	11. (a)	12. (b)	13. (b)					

Recent Question 2019 with explanations have also been given in the respective chapters.

AIIMS NEW PATTERN 2019 MODEL QUESTIONS

EXTENDED MATCHING QUESTIONS (EMQs)

1. **Theme:** Fundus dystrophies
   - **A.** Oguchi's disease
   - **B.** Chediak-Higashi syndrome
   - **C.** Hermansky-Pudlak syndrome
   - **D.** Retinopathy of prematurity
   - **E.** Stargardt's disease
   - **F.** Leber's congenital amaurosis
   - **G.** Coat's disease
   - **H.** DIDMOAD
   - **I.** Gyrate atrophy
   - **J.** Achromatopsia
   - **K.** Vitamin A deficiency

   Lead: For each of the following patients, identify the cause from the above listed options.

   Scenarios:

   1. 16 year old male has poor central vision for the past 2 years. Fundus examination reveals white flecks in both eyes. On Fluorescein angiography fluorescence from the choroidal circulation is not seen.

      Ans. (E) Stargardt's disease is the most common form of hereditary macular degeneration. It is characterized by white flecks in the posterior segment and macular abnormalities (atrophy often occurs at late stage). Fluorescein angiography typically shows dark choroid as a result of accumulation of abnormal materials in the RPE layer.

   2. 17 year old boy has white hair and nystagmus. Ocular examination shows pink coloured iris and has a pale white fundus. He is also prone to recurrent infection.

      Ans. (B) Chediak-Higashi syndrome consists of oculocutaneous albinism with immune deficiency. The patient is susceptible to recurrent infection.

   3. 25 year old man has poor vision at night. The ERG shows normal full-field ERG. The fundus in both eyes show colour changes during dark adaptation.

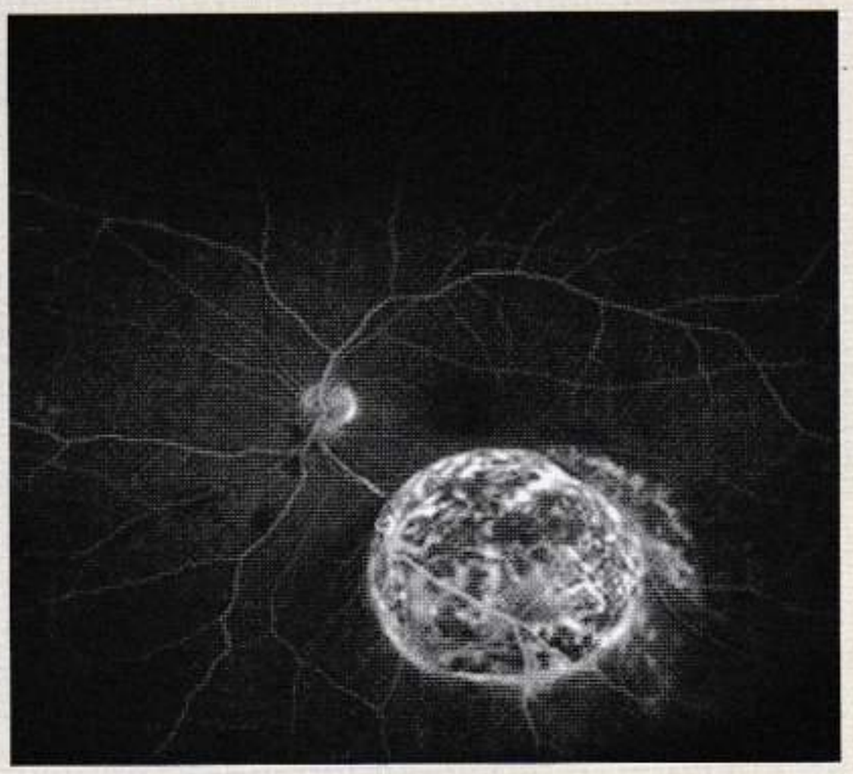
      Ans. (A) Oguchi's disease is a form of congenital stationary night blindness. Patients usually require 2 to 12 hours to attain normal dark-adapted rod thresholds and show a characteristic change from a golden brown colour of the fundus in the light-adapted state to a fundus of normal colour in the dark-adapted state (the "Mizuo phenomenon").

   4. A 2 year old boy has poor vision since the age of 5 months old with absent ERG and poor pupillary reaction to light. He also has the tendency to rub his eyes with his fingers

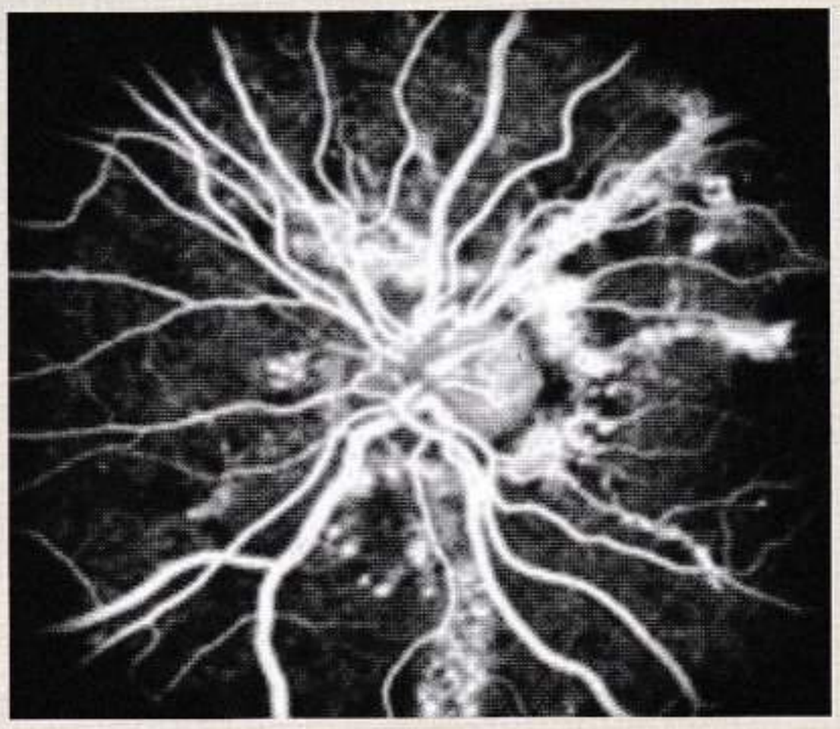
      Ans. (F) The criteria for the diagnosis of Leber's congenital amaurosis include visual impairment before age 6 months, poor pupillary reactions, and markedly attenuated or absent electroretinographic (ERG) responses. Eye rubbing is common and can result in endophthalmos due to orbital fat atrophy.

2. **Theme:** Fundus Fluorescein angiography
   - **A.** Choroidal Melanoma
   - **B.** Diabetic retinopathy with microaneurysms
   - **C.** Proliferative diabetic retinopathy
   - **D.** Morning glory syndrome
   - **E.** Angioid streaks
   - **F.** Sickle cell retinopathy
   - **G.** Subfoveal choroidal neovascularization in age-related macular degeneration
   - **H.** Juxtafoveal choroidal neovascularization in age-related macular degeneration
   - **I.** Hypertensive retinopathy
   - **J.** Central serous retinopathy
   - **K.** Macroaneurysms

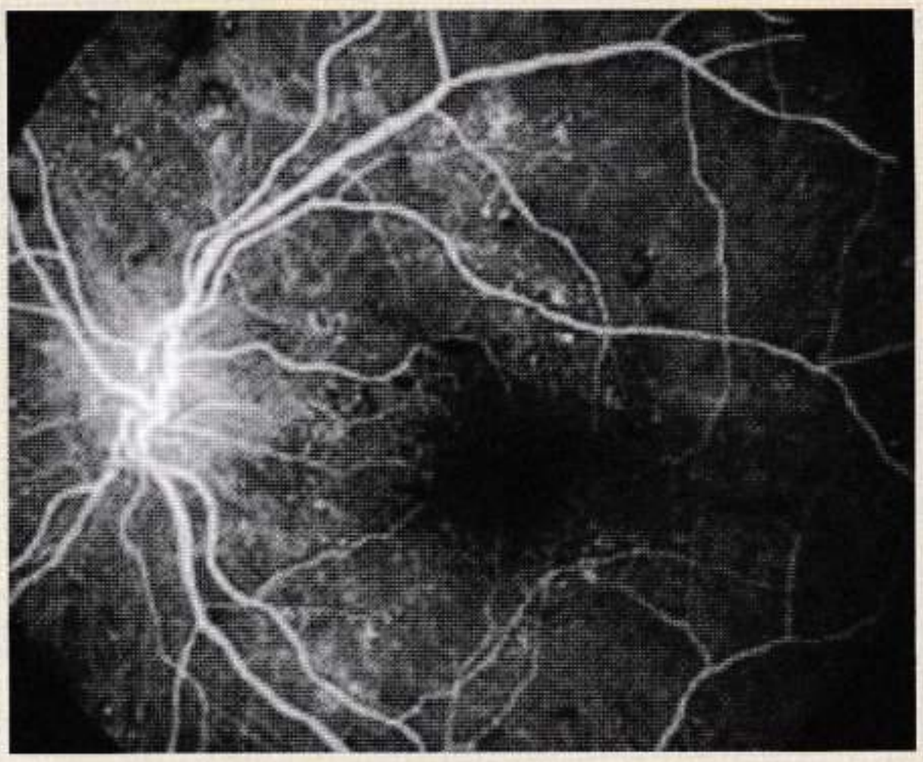
   Lead: Match the fluorescein angiographies with the most likely options listed above

   1. 

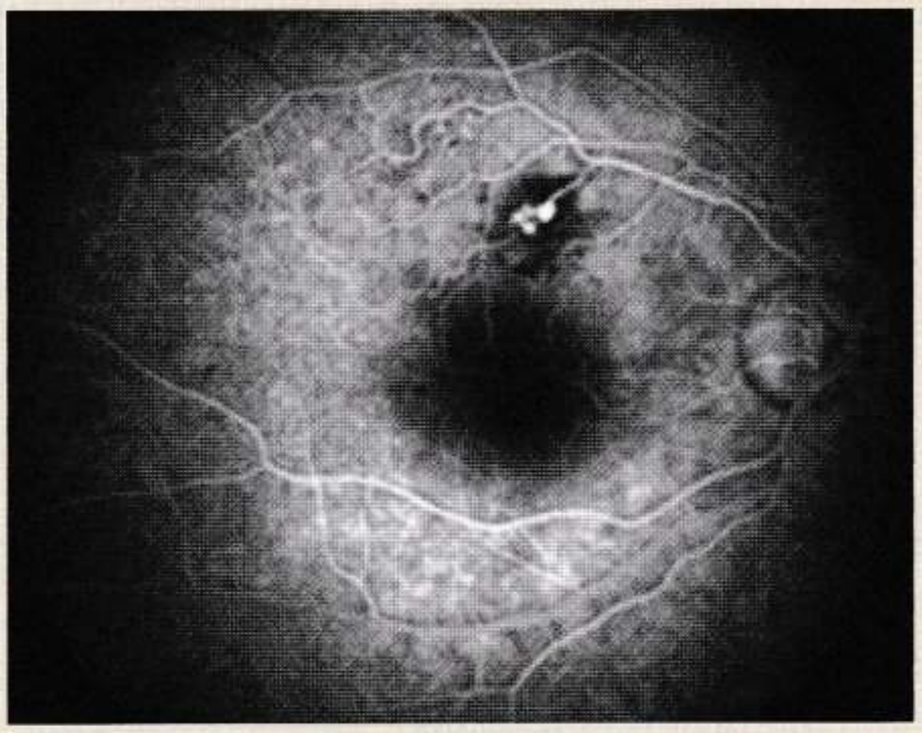
      Ans. (A) Double circulation is visible i.e. retinal vessels over the tumour elevation and intrinsic vessels are seen within the tumour – characteristic for Choroidal Melanoma. It is better visualized on ICG angiography

   2. 

      Ans. (E) The picture shows areas of hyperfluorescence under the retina (note retinal vessels run over them) radiating from the optic disc. These features are typical of angioid streaks.

3. 

Ans. (B) Background diabetic retinopathy with microaneurysms. The fluorescence angiography is at the venous phase and exhibits multiple spots of hyperfluorescence typical of microaneurysms. There is no evidence of significant macular oedema.

4. 

Ans. (K) The fluorescence angiography shows an area of hyperfluorescence arising from the second order retinal artery with a surrounding area of hypofluorescence (from exudate or haemorrhage). This is typical of a macroaneurysm.

3. **Theme:** Neuro-muscular disorders
   - **A.** Occulomotor nerve palsy due to aneurysm of the posterior communicating artery
   - **B.** Multiple Sclerosis
   - **C.** Blepharospasm
   - **D.** Preganglionic Horner's syndrome
   - **E.** Postganglionic Horner's syndrome
   - **F.** Myasthenia gravis
   - **G.** Diabetic occulomotor nerve palsy
   - **H.** Superior oblique palsy
   - **I.** Chronic progressive external ophthalmoplegia
   - **J.** Myotonic Dystrophy
   - **K.** Pontine lesions

   Lead: Match the clinical scenarios given below with the best possible diagnosis from the options given above.

1. **A 42 year old woman has a 10 year history of progressive bilateral ptosis. She also has bilateral cataract and complaints of weakness of lid closure. The ocular movements in both eyes are normal.**

   Ans. (J) In myotonic dystrophy, there is weakness of orbicularis but the eye movement is normal. In addition, pre-senile cataract is common.

2. **A 60 year old woman with a 4 week history of headache complains of horizontal double vision. Examination reveals a right sixth nerve palsy with mild ptosis and constricted pupil.**

   Ans. (E) The history suggests a lesion within the cavernous sinus involving the sixth cranial nerve and the sympathetic nervous pathway. One possibility is an internal carotid artery aneurysm. Metastasis is also a possibility.

3. **A 50 year old man who has polydipsia and polyuria develops a sudden onset vertical diplopia. Examination reveals a right hypotropia and the pupil are normal.**

   Ans. (G) Polydipsia and polyuria suggests diabetes mellitus. A hypotropia without pupil involvement suggests a medical partial third nerve palsy.

4. **A 30 year old woman develops a binocular double vision. Examination reveals limited adduction in both eyes and fine nystagmus on abduction in either eye. Pupil examination reveals a right afferent pupillary defect.**

   Ans. (B) The ocular motility abnormality suggests bilateral internuclear ophthalmoplegia. The pupil abnormality suggests a previous optic neuritis. These signs occurring in a young woman are consistent with multiple sclerosis ie. clinical signs separated in space and time.

4. **Theme:** Course of Cranial Nerves
   Match the following findings (a-d) with the most likely cause or site of lesion (A-N) listed below.
   - **A.** Orbital apex
   - **B.** Dilatation of the third ventricle
   - **C.** Occipital Lobe
   - **D.** Cavernous sinus
   - **E.** Red nucleus
   - **F.** Cerebral peduncle
   - **G.** Superior orbital fissure
   - **H.** Inferior orbital fissure
   - **I.** Cervicomedullary junction
   - **J.** Ventral pons
   - **K.** Dorsal pons

   Lead: Match the following findings with the most likely site of lesion

1. **24 year-old girl developed morning headache with vomiting and has a bitemporal hemianopia. CT scan revealed dilated lateral ventricles and a space-occupying lesion in the brain stem. No lesions were seen in the pituitary or the hypothalamus region. What may be responsible for the visual field defect?**

   Ans. (B) The chiasm is located at the junction of the floor and the anterior wall of the third ventricle at the base of the

brain. Obstructive hydrocephalus may produce an enlarged third ventricle, which, acting as a mass, compresses the chiasm.

2. **A 75 year-old woman developed a sudden onset right third nerve palsy. In addition, she also developed a left involuntary tremor.**

Ans. (E) A oculomotor palsy and contralateral tremor suggest a lesion in the region the red nucleus commonly called Benedikt's syndrome

3. **80 year-old man developed a right sided Bell's palsy and a right horizontal gaze palsy.**

In addition, he had a right Horner's syndrome and loss of sensation to the right face.'

Ans. (J) Lesion of the ventral pons also called Foville's syndrome. Foville's syndrome combines an abduction or horizontal gaze deficit with ipsilateral facial weakness, ipsilateral loss of taste, ipsilateral facial analgesia, ipsilateral Horner's syndrome, and ipsilateral deafness. The structures affected are the abducens fascicles or nucleus, the facial nerve fascicles, the nucleus of the tractus solitarius, the spinal tract of the trigeminal nerve, the central tegmental tract, and the cochlear nuclei, respectively.

4. **A 32 year-old woman developed a painful right eye and proptosis. Examination revealed normal vision but right eye had partial ophthalmoplegia and the right forehead had decreased sensation to touch and pain. The left eye examination was normal.**

Ans. (G) The history and physical signs suggest a lesion in the superior orbital fissure. The sensory nerves to the forehead travel through the superior orbital fissure. The presence of a mass lesion in the orbital apex would produce a compressive optic neuropathy in addition to dysfunction of the ocular motor nerves, and proptosis. Lesion of the cavernous sinus produces minimal or no proptosis (except in carotid cavernous fistula) and the contralateral eye tends to be affected.

5. **Theme:** Syndromic associations – Neuro-ophthalmology
   - **A.** Anton's syndrome
   - **B.** Foster Kennedy syndrome
   - **C.** Foville's syndrome
   - **D.** Wallenberg's syndrome
   - **E.** Millard-Gubler's syndrome
   - **F.** Gradenigo's syndrome
   - **G.** Weber's syndrome
   - **H.** Raymond's syndrome
   - **I.** Benedikt's syndrome
   - **J.** Tolosa hunt syndrome
   - **K.** Nothnagel's syndrome

   Lead: For each of the patient described in the scenarios below, identify the cause from the options list above

   1. **A 50 year-old hypertensive man developed a sudden onset slurring of speech, vomiting and a right Horner's syndrome. He also had problem with standing up straight. Ocular examination also revealed a horizontal jerky nystagmus.**

Ans. (D) The cardinal symptoms of the lateral medullary syndrome (Wallenberg's syndrome) are sharp pain in the ipsilateral eye or burning of the face, dizziness or vertigo, ataxia, hoarseness, clumsiness of the ipsilateral arm and leg, and difficulty standing or walking. The major ocular and oculomotor signs are an ipsilateral Horner syndrome, nystagmus, and occasionally ocular pulsion toward the side of the lesion.

   2. **A 60 year-old hypertensive man developed a sudden onset right ptosis with inability of adduction and elevation and a left hemiplegia.**

Ans. (G) A third-nerve dysfunction plus contralateral hemiparesis implicates involvement of the ipsilateral cerebral peduncle. This is called Weber's syndrome.

   3. **A 30 year-old man developed a right sixth nerve palsy and facial pain. CT scan revealed opacity of the mastoid air cells.**

Ans. (F) Gradenigo's syndrome. Where the sixth nerve enters the dura above the clivus and along the petrous ridge, it is susceptible to processes involving the adjacent mastoid air cells, such as mastoiditis. Inflammation in this region consists of abducens palsy, severe facial and eye pain (resulting from involvement of the adjacent gasserian ganglion), and sometimes facial

   4. **A 65 year-old diabetic woman developed a sudden-onset right facial palsy and a contralateral hemiplegia. Examination revealed a right abduction deficit.**

Ans. (E) Millard-Gubler syndrome combines an abduction deficit with contralateral hemiplegia and ipsilateral facial paralysis, implying involvement of the abducens fascicles, the pyramid, and the facial nerve fascicles.

6. **Theme:** Ocular Microbiology
   - **A.** Gram positive coccus
   - **B.** Gram negative coccus
   - **C.** Gram positive bacillus
   - **D.** Gram negative bacillus
   - **E.** Acid fast bacilli
   - **F.** Cytoplasmic inclusion bodies on Giemsa staining
   - **G.** Multi-nucleated cells and inclusion bodies on Tzanck test
   - **H.** Grow on agar plate overlaid with E. coli
   - **I.** Stained with Gomori methenamine silver
   - **J.** Stained with Sudan black

   Lead: For each of the patient described in the scenarios below, match the causative micro-organism from the options list above

   1. **A 25 year old woman presented with a painful loss of vision. On slit lamp examination a corneal ulcer with thick mucus adherent to the defect is visible in the right eye. She gives history of having scratched her right cornea while removing a soft contact lens, yesterday.**

Ans. (D) The rapid onset and thick mucous at the site of the ulcer in a contact lens user is suggestive of *Pseudomonas aeruginosa*, a Gram negative bacillus.

2. **A 25 year old man has a right follicular conjunctivitis that recurs when treatment is stopped. He is also taking treatment for non-specific urethritis.**

Ans. (F) Recurrent follicular conjunctivitis in a patient with non-specific urethritis suggests chlamydial conjunctivitis. Giemsa staining of the conjunctival scrap will show cytoplasmic inclusion bodies.

3. **A 70 year old man develops painful vesicles on his right forehead and tip of nose. On slit lamp examination, the right eye has congestion, mucous discharge and decreased corneal sensitivity.**

Ans. (G) The clinical features are that of ophthalmic shingle. Tzanck smear of the fluid taken from the vesicles typically show multinucleated cells and inclusion bodies. These features are also seen in herpes simplex.

4. **A 25 year old male intravenous drug user presents with blurring of vision in the right eye. Fundus examination reveals the presence of vitritis and multiple fluffy cotton white lesions.**

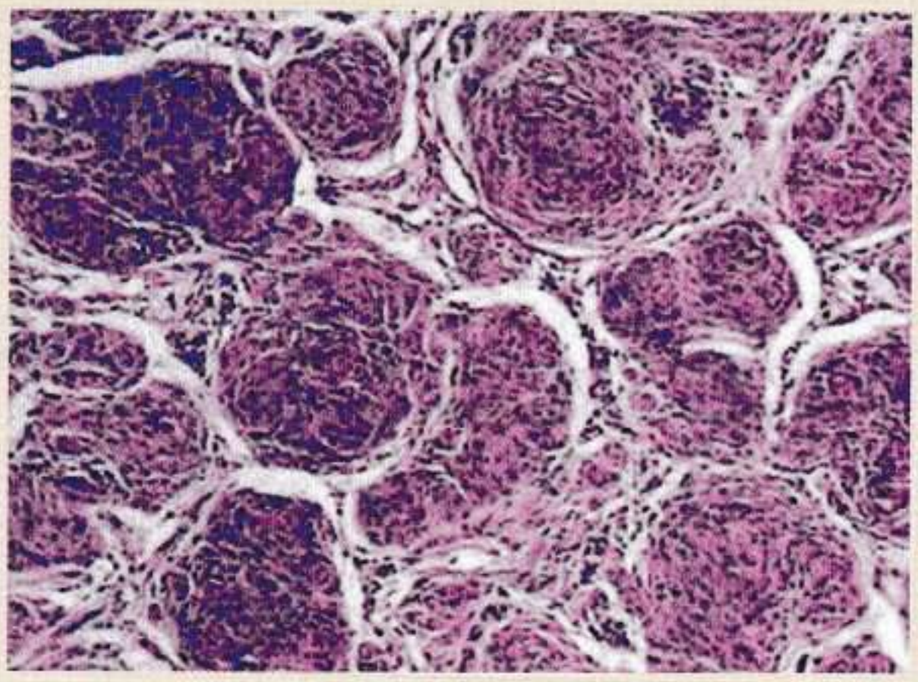
Ans. (I) The history is suggestive of endophthalmitis caused by candidiasis. The pathogen takes up Gomori methenamine silver stain readily.

7. **Theme:** Orbital Pathology

A. Mucomycosis
B. Pleomorphic adenoma
C. Lymphoma
D. Cavernous haemangioma
E. Optic glioma
F. Myositis
G. Lymphangioma
H. Neuroblastoma
I. Rhabdomyosarcoma
J. Retinoblastoma
K. Meningioma
L. Thyroid eye disease
M. Neurofibroma
N. Dermoid

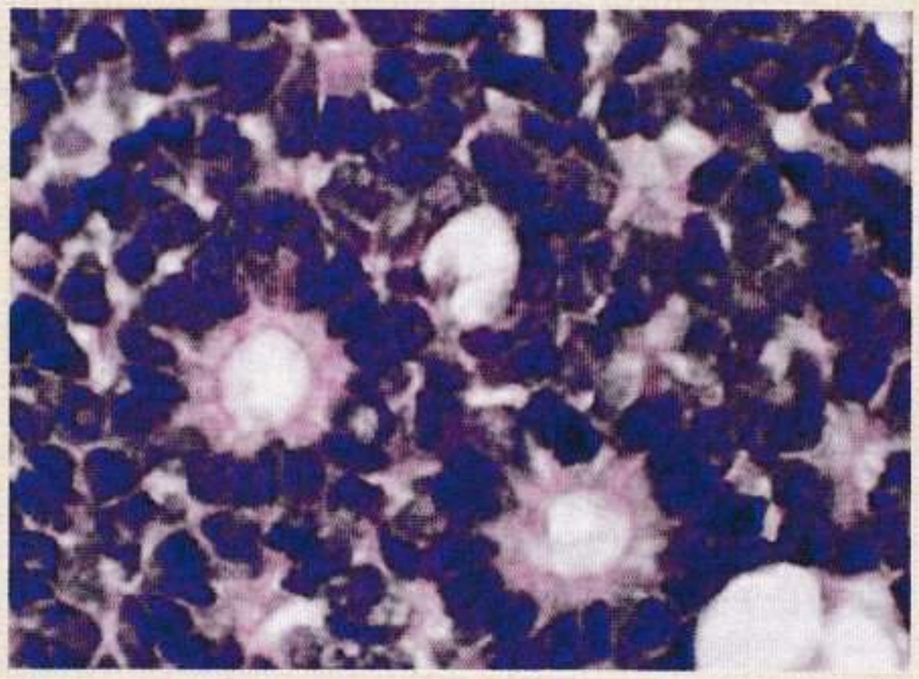
Lead: For each of the histopathology slide given below match the causative orbital pathology

1.



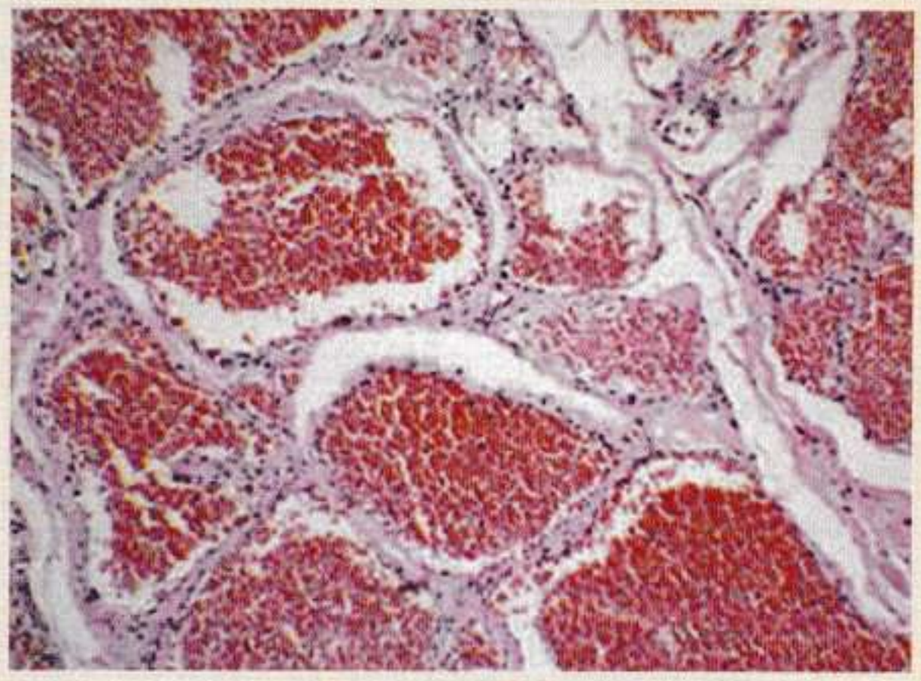
Ans. (K) Meningioma. The slide shows whirls of fibrous tissue which are characteristic of meningioma. The other feature of meningioma not seen here is calcified psamomma bodies.

2.



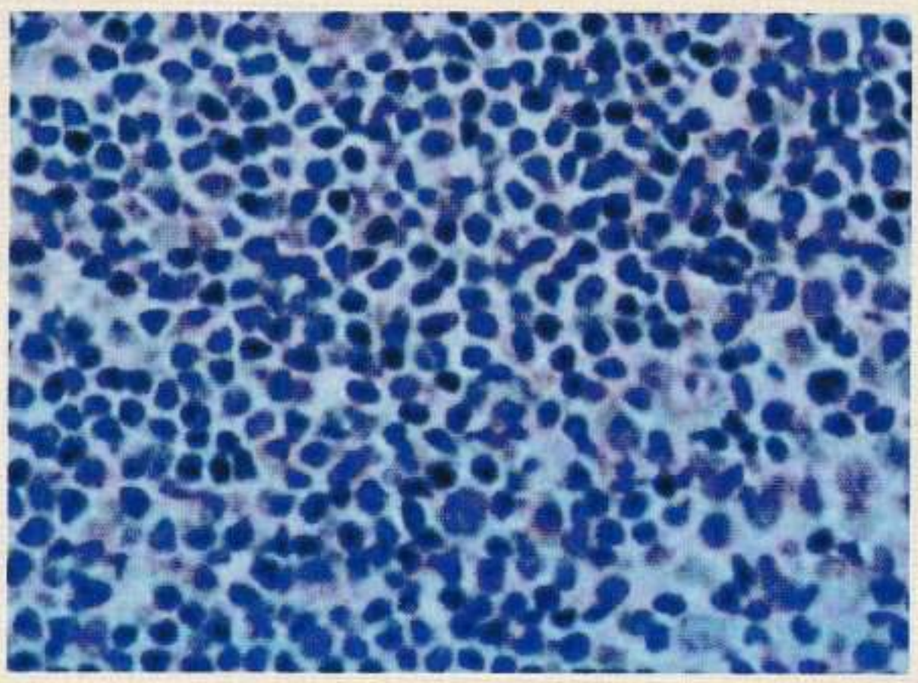
Ans. (J) Retinoblastoma. The slide shows small round cells with large hyperchromatic nuclei and scanty cytoplasm. There are also Flexner Wintersteiner rosettes which are clusters of cuboidal or short columnar cells arranged around a central lumen.

3.



Ans. (D) Cavernous haemangioma. The lesion contains varying sized vascular channels with lumina, sclerotic wall and flattened endothelial cells

4.



Ans. (C) Lymphoma. The slide shows monotonous sheets of small blue cells. Systemic evaluation is necessary for extraorbital lymphoma. The majority of the lymphomas are monoclonal B cell proliferation. Irradiation is the treatment of choice for lymphoma confined to orbit and the result is good. Systemic lymphoma can present years after having isolated orbital disease and long-term follow up is essential.

8. **Theme:** Raised Intraocular pressure
   - **A.** Schwartz's syndrome
   - **B.** Peter's anomaly
   - **C.** Phacomorphic glaucoma
   - **D.** Phacoanaphylactic glaucoma
   - **E.** Buphthalmos
   - **F.** Iridocorneal endothelial syndrome
   - **G.** Sturge Weber syndrome
   - **H.** Posterior polymorphous dystrophy
   - **I.** Neurofibromatosis
   - **J.** Malignant glaucoma
   - **K.** Axenfeld's syndrome

Lead: For the following history and clinical signs what is the most likely diagnosis from the options given above.

1. **An 8 year-old patient has bilateral prominent Schwalbe's line with peripheral anterior synechiae and corectopia. The pressures in both eyes measure 28 mmhg. The cornea in both eyes appear normal.**

Ans. (N) Axenfeld's syndrome has iris abnormalities such as hypoplasia of the anterior layer of the iris stroma. In some cases, the pupil may be situated abnormally (corectopia) or is abnormal in shape (slit pupil). Multiple pupils (polycoria) and false pupils (pseudocoria) also occur. Prominence and anterior displacement of Schwalbe's line into the clear portion of the cornea, termed posterior embryotoxon is a common feature. Just over 50% of patients have glaucoma.

2. **A 46 year-old man has bilateral glaucoma. Examination reveals peripheral anterior synechiae, corectopia and iris atrophy in both eyes. In additions, there are band like lesions and islands of endothelial changes at the level of Descemet's membrane.**

Ans. (H) Posterior polymorphous dystrophy may be confused with ICE syndrome. Less than 15% develop glaucoma. Unlike ICE, it is a bilateral condition and has an autosomal dominant inheritance. Findings on examination show posterior cornea with single or groups of blisters/ vesicles, band like lesions with scalloped edges, or islands with endothelial changes at level of Descemet's membrane. Some have peripheral anterior synechiae, corectopia, iris atrophy and it is these features that make it resemble ICE syndrome. However, the majority of the patients are asymptomatic.

3. **A 70 year-old woman underwent a right trabeculectomy for primary open angle glaucoma. 24 hours after the operation the anterior chamber is noted to be shallow and the intraocular pressure measures 43 mmHg. The iridectomy appears patent.**

Ans. (J) Malignant glaucoma also calls ciliary block glaucoma or aqueous misdirection. The characteristic findings are elevated IOP after filtering surgery, with central shallowing of the anterior chamber, a patent iridotomy or iridectomy, and the absence of suprachoroidal effusion or haemorrhage. This occurs in 0.6 to 4% acute angle-closure glaucoma undergoing intraocular surgery.

4. **A 54 year-old man has a red right eye and decreased vision. On examination, he has a superior retinal detachment and a mild anterior chamber inflammation. The intraocular pressure measures 32 mmHg and responded poorly to anti-glaucoma eyedrops. Post-operatively, the intraocular pressure returns to normal spontaneously without further treatment.**

Ans. (A) Schwartz's syndrome is open-angle glaucoma associated rhegmatogenous retinal detachment. There is usually mild anterior chamber reaction. The cause of the glaucoma is not known but has been attributed to iridocyclitis or blockage of the trabecular meshwork by retinal pigment epithelium cells or photoreceptors. The glaucoma typically resolves following retinal detachment operation.

9. **Theme:** Anti-glaucoma drugs
   - **A.** Brimonidine
   - **B.** Pilocarpine
   - **C.** Acetazolamide
   - **D.** Latanoprost
   - **E.** Timolol
   - **F.** Oral acetazolamide
   - **G.** Dorzolamide
   - **H.** Dipivefrine

Lead: For the clinical scenarios given below, match the best medication indicated

1. **A 78 year-old woman has been taking an anti-glaucoma eyedrop for the past 20 years. The pressures in both eyes measure 18 mmHg. Examination reveals the presence of black deposits in the lower tarsal conjunctiva of both eyes. What medication is she likely to be on?**

Ans. (H) Dipivefrine is the prodrug of adrenaline. It is seldom used nowadays. Adrenaline is oxidized to adrenochrome and can cause black conjunctival deposits.

2. **A 54 year-old woman with a past history of ophthalmic shingle develops right anterior uveitis, raised intraocular pressure and also mild corneal edema. She is on tricyclic antidepressant for post-herpetic neuralgia. Which anti-glaucoma medication is preferable?**

Ans. (E) Timolol is the treatment of choice as the patient has no history of shortness of breath. Pilocarpine and latanoprost can exacerbate the inflammation. In

the presence of corneal decompensation, carbonic anhydrase inhibitor is contraindicated. Bromonidine is contraindicated in patients taking tricyclic antidepressant as it can cause hypertensive crisis.

3. **A 78 year-old asthmatic has bilateral mild ptosis and early glaucoma with raised intraocular pressures of RE 25 and LE 28. He was given an anti-glaucoma treatment. On review four weeks later, the pressures in both eyes are controlled and the ptosis improves. Which anti-glaucoma medication might have been given in this patient?**

Ans. (A) Bromonidine can cause eyelid retraction and may explain the reduction of the ptosis. Dipivefrine is also a possibility but it is rarely prescribed nowadays.

4. **A 29 year-old woman has bilateral pigment dispersion syndrome and raised intraocular pressures measuring RE 39 and LE38. She is a keen sport woman and trains regularly for long-distance running. Which anti-glaucoma medication is preferable?**

Ans. (C) Acetazolamide

10. Theme: Ocular Motility

A. Moëbius syndrome
B. Duane's syndrome
C. Brown's syndrome
D. Left superior rectus palsy
E. Right fourth nerve palsy
F. Left fourth nerve palsy
G. Non-accommodative esotropia
H. Infantile esotropia
J. Accommodative esotropia
I. Consecutive esotropia

Lead: For the clinical presentation and history given below, diagnose the most likely condition from the options given above.

1. **A 36 year-old woman complaints of vertical binocular diplopia in the primary position.**
Examination with a torchlight reveals a left hypotropia in the primary position. With the head tilt to the right or with left gaze, there is a right hypertropia, but no tropia is present with the head tilt to the left side

Ans. (E) In fourth nerve palsy, the affected eye tends to be hypertropic. However, if the affected eye is the fixating eye, the unaffected eye may become hypotropic. With the head tilt to the affected side, the deviation is revealed or increased.

2. **A 6 year-old girl had bilateral esotropia and absent facial expression with punctate corneal staining due to exposure keratopathy. Corneal sensations are normal.**

Ans. (A) The findings are those of Moëbius syndrome.

3. **A 7 year-old girl has a right esotropia measuring 40 Δ for distance. Examination reveals a visual acuity of RE 6/24 and LE of 6/12. Cycloplegic refraction shows**

RE +6.00/-1.25 × 40 and LE +5.5/-1.50 × 145.

Wearing glasses with the prescription of

RE +4.5/-1.25 × 40 and LE +4.00/-1.50 × 145.

The esotropia is reduced and measured as 4 Δ.

Ans. (J) The patient has a significant esotropia and hypermetropia. The esotropia is significantly reduced with glasses correction.

4. **A 55 year-old has a right constant exotropia and poor vision due to a macular chorioretinal scar from congenital toxoplasmosis. Examination reveals a large exotropia measuring 42 Δ. Surgery was performed to reduce the exotropia. Post-operatively the patient develops a slight esotropia measuring 5pd.**

Ans. (I) Consecutive esotropia refers to a convergent strabismus that has developed following surgery for an exotropia.

11. Theme: Examination of Squint

A. Infantile esotropia
B. Refractive accommodative esotropia
C. Non-refractive accommodative esotropia
D. Paralytic esotropia
E. Restrictive strabismus

Lead: Based on the examination findings given for the scenarios, match the most likely group of strabismus from the options listed above.

1. **Cover Test: Left Convergent Squint**
Prism Cover Test: Near - BO 45 Δ
Distance - BO 35 Δ
Cycloplegic refraction: RE +5.25D LE +5.75D

Ans. (B) Refractive accommodative esotropia is characterized by a moderate distance deviation that increases for near fixation and a high hypermetropia.

2. **Cover Test: Left Convergent Squint**
Prism Cover Test: Near - BO 10 Δ
Distance - BO 35 Δ
Ocular Movement: Incomitant deviation, increased deviation with attempted abduction of the left eye.
Cycloplegic refraction: RE +0.75D
LE +0.50D

Ans. (E) Paretic esotropia usually has a larger degree of deviation for distance than near. And the ocular movement is non-comitant.

12. **Theme:** Pigmentary Retinopathy

A. Leber's congenital amaurosis
B. Myotonic dystrophy
C. Kearns-Sayre syndrome
D. Congenital rubella syndrome
E. Usher's syndrome
F. Bardet-Biedl syndrome
G. Refsum's disease
H. Friedreich's ataxia
I. Bassen-Kornzweig syndrome
J. Syphilis

Lead: Based on the clinical presentation diagnose the cause of pigmentary retinopathy from the options listed above.

1. **A 30 year old man has cerebellar signs, deafness, elevated phytanic acid and pigmentary retinopathy.**

Ans. (G) Refsum's disease is an autosomal recessive condition. The clinical findings include a peripheral neuropathy, ataxia, an increase in cerebrospinal fluid protein with a normal cell count, and retinitis pigmentosa. Elevated serum phytanic acid is seen in all cases.

2. **A 15 year old girl has absence of low-density plasma lipoproteins with abnormal shape red blood cells and pigmentary retinopathy.**

Ans. (I) It is also known as abetalipoproteinemia, it is an autosomal recessive disorder with malabsorption, absence of low-density plasma lipoproteins and star-shaped erythrocytes and pigmentary retinopathy similar to retinitis pigmentosa. Treatment is with low fat diet, and vitamin A, E and K.

3. **A 19 year old woman has been wheel-chair bound since the age of 12 with kyphoscoliosis, cerebellar signs and pigmentary retinopathy.**

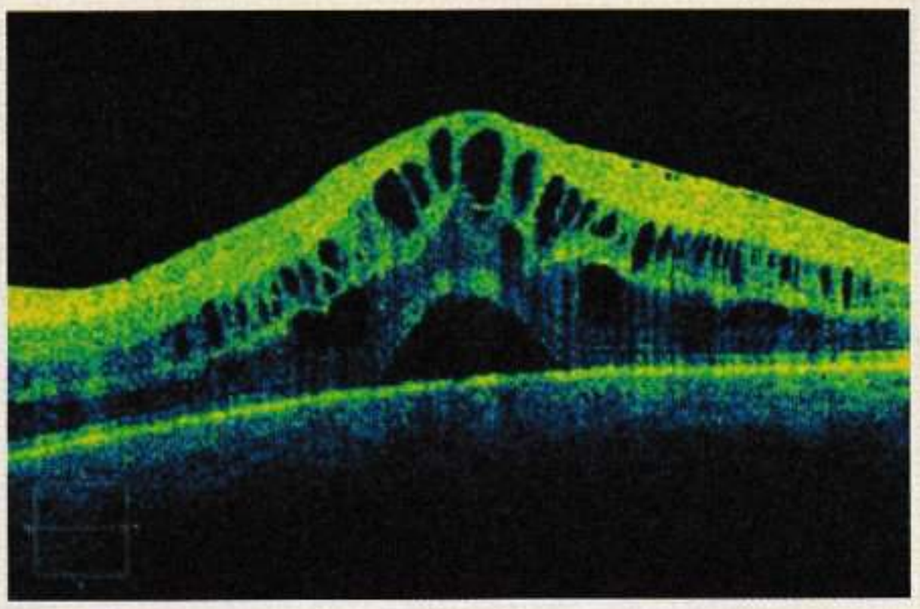
Ans. (H) Friedreich's ataxia is a rare autosomal recessive disorder characterized by cerebellar kyphoscoliosis, pes cavus, diabetes mellitus, optic atrophy and pigmentary retinopathy. Most patients lose their mobility in their teens.

13. **Theme:** Optical Coherence Tomography

A. Macular edema
B. Retinoschisis
C. Macular pseudohole
D. Central Serous retinopathy
E. Retinal detachment
F. Stage 3 macular hole
G. Stage 4 macular hole
H. Choroidal neovascularization
I. Macular drusen
J. Pigment epithelium detachment

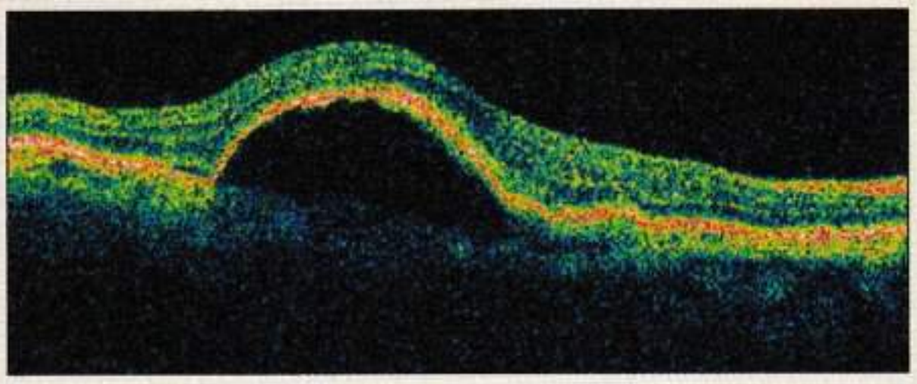
Lead: Match the OCT picture given with the most likely diagnosis

1.



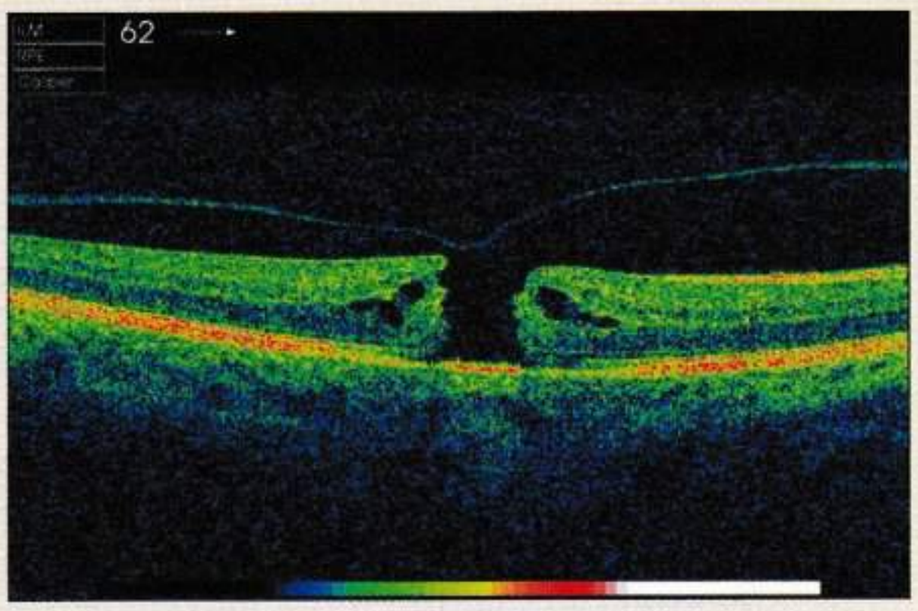
Ans. (A) Macular oedema. The scan shows multiple cystic spaces within the retina. This patient has diabetic maculopathy.

2.



Ans. (J) Pigment epithelium detachment. The OCT shows elevations of the retina and the retinal pigment epithelium suggesting the presence of fluid under the retinal pigment epithelium layer. This patient has choroidal neovascularization due to age-related macular degeneration.

3.



Ans. (F) Stage 3 macular hole. The OCT shows a full thickness macular hole with an overlying operculum attached to the vitreous phase.

For stage 4 image, see text in Chapter 8 – FTMH is with complete PVD

14. **Theme:** Corneal dystrophies

A. Schnyder's crystalline dystrophy
B. Reis-Buckler's dystrophy
C. Fuch's endothelial dystrophy
D. Macular dystrophy
E. Granular dystrophy
F. Keratoconus
G. Map-dot dystrophy
H. Meesman's dystrophy

Lead: Match the following pathology reports from a corneal button with the most likely diagnosis

1. **There are deposits of lipid and cholesterol within the superficial to middle stroma; no blood vessels are seen within the stroma.**

Ans. (A) Schnyder's crystalline dystrophy is an autosomal dominant corneal dystrophy characterized by the presence of lipid and unesterfied cholesterol crystals within the stroma.

2. **This section shows the presence of multiple breaks in Bowman's layer with centrally thinned epithelium and stroma.**

Ans. (F) This is the features of keratoconus.

3. **The epithelium of the cornea shows multiple intraepithelial cysts with normal stroma and endothelium.**

Ans. (H) Multiple intraepithelial cysts are features of Messman's dystrophy. They tend to appear at the base of the epithelium and move upward.

4. **The cornea shows diffuse deposit within the stroma that stains blue with colloidal iron.**

Ans. (D) The mucopolysaccharide in macular dystrophy can be stained with colloidal iron to show the diffuse deposits.

15. **Theme:** Phakomatosis
   - **A.** Wyburn-Mason
   - **B.** Sturge-Weber
   - **C.** von Hippel-Lindau
   - **D.** Ataxia telangiectasia
   - **E.** Neurofibromatosis type 1
   - **F.** Tuberous sclerosis

   Lead: Choose the phakomatosis that match the following features.....

1. **Ataxia, conjunctival telangiectasia and normal MRI scan.**

Ans. (D) Louis-Bar syndrome also known as ataxia-telangiectasia has no central nervous system abnormalities that can be detected on MRI scan. Ocular motor abnormalities are found in many patients with AT and are frequently among the earliest manifestations.
Strabismus and nystagmus may also be present.
Telangiectasia of the conjunctiva develops between the ages of 3 and 5 years.

2. **Mental retardation, epilepsy and calcification of the cerebral blood vessels.**

Ans. (B) Several phakomatosis are associated with mental retardation and epilepsy but only in Sturge-Weber syndrome is there calcification of the cerebral blood vessels.

3. **Ataxia, polycythaemia, renal and hepatic cysts and pheochromocytoma**

Ans. (C) von Hippel-Lindau is the only one which has all the above features. The ataxia and polycythaemia are the results of cerebellar haemangioblastoma that secretes erythropoietin.

4. **Mental retardation, epilepsy, astrocytic hamartoma and subungual fibroma.**

Ans. (F) Subungual fibroma is characteristic of tuberous sclerosis which also has the other the other features.

SEQUENTIAL ARRANGEMENT TYPE

16. **Arrange the following test/methods in order of use while recording vision in a patient.**
   - a. Snellen's chart
   - b. Projection of light rays
   - c. Hand movement
   - d. Perception of light
   - e. Finger counting

Ans. a, e, c, b, d

Ref: Parsons' 22/e, p. 99

17. **Arrange the visual field defects in order of occurrence in a patient with primary open angle glaucoma.**
   - a. Bjerrum scotoma
   - b. Loss of central vision
   - c. Paracentral scotoma
   - d. Isopter contraction
   - e. Loss of temporal vision

Ans. d, c, a, b, e

Refer Chapter 6 – Page no. 201

18. **Arrange the following for steps performed in phacoemulsification.**
   - a. Hydrodissection
   - b. Nuclear fragmentation
   - c. Implantation of IOL
   - d. Staining of Anterior capsule of lens
   - e. Continuous curvilinear capsulorhexis

Ans. d, e, a, b, c

Refer Chapter 5 – Page no. 162

19. **Arrange the following lasers in order of decreasing wavelength.**
   - a. Argon
   - b. Nd:YAG
   - c. Excimer
   - d. Diode
   - e. Nd:Glass
   - f. Frequency doubled Nd:YAG

Ans. b, e, d, f, a, c

Ref: Parson's 22/e, p. 608

(Nd:YAG)1064 > (Nd:Glass)1053 > (Diode)800 > (Frequency doubled Nd:YAG) 532 > (Argon green)514 > (Excimer)193

20. Arrange the following colour of nucleus according to increasing grade hardness.

a. Yellow
b. Brown
c. Black
d. Amber

Ans. a, d, b, c

Ref: Parson's 22/e, p. 276

21. Arrange the following events in order of occurrence during development

a. Formation of optic vesicle
b. Formation of lens vesicle
c. Formation of primary lens fibres
d. Formation of Y shaped sutures

Ans. a, b, c, d

Ref: Khurana Anatomy 2/e, p. 11-12

22. Arrange the layers of retina from anterior to posterior

a. Retinal pigment epithelium
b. Ganglion cell layer
c. Inner nuclear layer
d. Inner plexiform layer
e. Photoreceptors

Ans. b, d, c, e, a

Ref: Parson's 22/e, p. 612

23. Arrange the layers of cornea from outermost to innermost.

a. Epithelium
b. Dua's layer
c. Descemet membrane
d. Bowman's layer
e. Endothelium
f. Stroma

Ans. a, d, f, b, c, e

Ref: Khurana 6/e

24. Arrange the components of eye in decreasing order of refractive indices

a. Periphery of lens
b. Aqueous
c. Cornea
d. Centre of lens

Ans. d, a, c, b

Ref: Parson's 22/e, p. 49

25. Arrange the following in order of the sympathetic pathway for pupil.

a. Ciliospinal budge
b. Hypothalamus
c. Superior cervical ganglion
d. Long ciliary nerve

Ans. b, a, c, d

Ref: Parson's 22/e, p. 34

26. Arrange the surgeries based on range of myopia corrected by each, in an increasing order.

a. LASIK
b. PRK
c. Clear lens extraction
d. INTACS

Ans. b, d, a, c

Ref: Parson's 22/e, p. 74

27. Arrange the structures in the angle from behind forwards.

a. Scleral spurb Schwalbe's line
c. Ciliary body band
d. Anterior surface of iris
e. Trabecular meshwork

Ans. d, c, a, e, b

Ref: Parson 22/e, p. 128

28. Arrange the following steroidal agents according to their anti-inflammatory potency.

a. Difluprednate
b. Betamethasone
c. Methylprednisolone
d. Fluorometholone

Ans. a, d, b, c

Ref: Parson's 22/e, p. 154

Commonly used steroids and their anti-inflammatory potency

Steroids used in ophthalmology	Common dosage	Anti-inflammatory potency
Difluprednate	0.05%	60
Fluorometholone	0.1%	40–50
Fluorometholone forte	0.25%	40–50
Dexamethasone sodium phosphate acetate	0.1/0.05%	25
Loteprednol etabonate	0.2–0.5%	25
Rimexolone	1%	25
Betamethasone	0.5%	25
Triamcinolone	1%	5
Methylprednisolone		5
Medrysone	1%	4
Prednisolone acetate/ phosphate	1%	4
Hydrocortisone	0.2%	1
Fluocinolone implant	0.59 mg	

29. **Arrange the clinical presentation according to the classification of trachoma by WHO.**
   a. Trachomatous intense inflammation
   b. Trachomatous scarring
   c. Trichiasis
   d. Trachomatous follicular inflammation
   e. Corneal opacity

Ans. d, a, b, c, e (FISTO classification)

30. **Arrange the following causative organisms for Ophthalmia neonatorum by the time of onset of discharge after birth.**
   a. HSV-II
   b. Chlamydia Trachomatis
   c. Neisseria gonorrhoeae
   d. Silver nitrate
   e. Staphylococci

Ans. d, c, e, a, b

31. **Arrange the following muscles in farthest to nearest order of their distance from limbus upon insertion on sclera.**
   a. Inferior rectus
   b. Medial rectus
   c. Superior rectus
   d. Lateral rectus

Ans. c, d, a, b

32. **Arrange the following in order for the treatment of intermediate uveitis.**
   a. Systemic prednisolone
   b. Parabulbar Steroids
   c. Photocoagulation of snowbank
   d. Azathioprine

Ans. b, a, d, c

33. **Arrange the following findings in order of occurrence in Primary angle closure glaucoma.**
   a. Peripheral anterior synechiae
   b. Iris bombe
   c. Optic nerve and visual field changes
   d. Relative pupillary block
   e. Irido-trabeculo-corneal contact

Ans. d, b, e, a, c

34. **Arrange the following quadrants in order of decreasing visual fields.**
   a. Temporal
   b. Superior
   c. Inferior
   d. Nasal

Ans. a, c, d, b

35. **Arrange the following structures in order with regard to aqueous outflow.**
   a. Superior ophthalmic vein
   b. Episcleral vein
   c. Trabecular meshwork
   d. Cavernous sinus
   e. Schlemm's canal
   f. Aqueous vein

Ans. c, e, f, b, a, d

36. **Arrange the following fundus findings in order of occurrence with respect to stages of Retinopathy of prematurity.**
   a. Partial retinal detachment
   b. Demarcation line
   c. Elevated ridge
   d. Total retinal detachment
   e. Extraretinal neo vascularization extending into vitreous

Ans. b, c, e, a, d

37. **Arrange the following steps in systemic order for examination and correction of refractor error.**
   a. Unaided visual acuity ascertained
   b. Pinhole visual acuity ascertained
   c. Retinoscopy
   d. Subjective refinement of retinoscopy findings
   e. Binocular muscle balancing
   f. Addition for near work

Ans. a, b, c, d, e, f

38. **Arrange the following in sequential order with respect to the technique of trabeculectomy.**
   a. Punch excision of deeper scleral tissue and trabecular opening
   b. Scleral flap sutured
   c. Partial thickness scleral flap dissected upto the limbus
   d. Peripheral iridectomy performed
   e. Limbal conjunctival flap raised

Ans. e, c, a, d, b

Ref: Parson's 22/e, p. 307; Kanski 7/e, p. 391

39. **Arrange the following diseases according to prevalence with respect to blindness.**
   a. Refractive errors
   b. Cataract
   c. Glaucoma
   d. Corneal blindness

Ans. b, a, c, d

MATCH THE FOLLOWING

40.

I. –1.25DS	a. Emmetropia
II. +0.75DS/+1DC @ 180	b. Simple myopic astigmatism – against the rule
III. –1.25DC @ 180	c. Simple myopic astigmatism – with the rule
IV. Plano	d. Compound hypermetropic astigmatism – against the rule
	e. Simple hypermetropic astigmatism – against the rule
	f. Compound hypermetropic astigmatism – with the rule
	g. Mixed astigmatism – with the rule
	h. Myopia

1. I – h, II – d, III – c, IV – a
2. I – h, II – g, III – b, IV – a
3. I – b, II – g, III – e, IV – a
4. I – a, II – f, III – c, IV – h

Ans. 1

41.

I. Infectious crystalline keratopathy	a. Alpha hemolytic streptococcus
II. Filamentary Keratopathy	b. Herpes simplex virus
III. Interstitial keratitis	c. Cogan syndrome
IV. Radial keratoneuritis	d. Staphylococcus aureus
	e. Herpes zoster virus
	f. Acanthamoeba
	g. Aspergillus

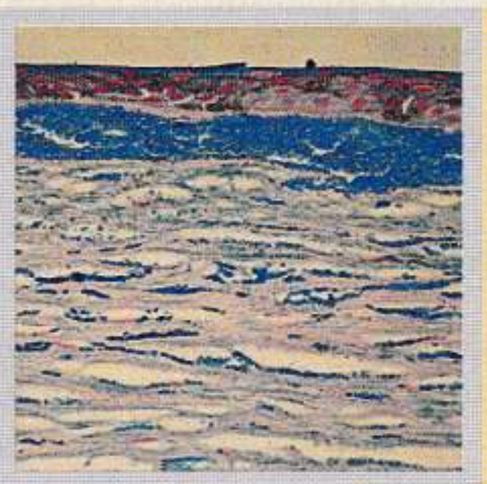
1. I – d, II – b, III – c, IV – f
2. I – a, II – b, III – c, IV – f
3. I – a, II – g, III – c, IV – e
4. I – c, II – g, III – a, IV – e

Ans. 2.

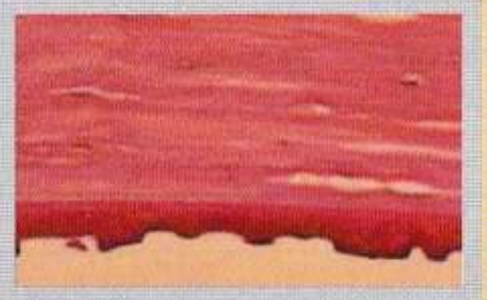
Ref: Parson's 22/e, p. 195, 198, 211; Kanski 7/e, p. 194

42.

I.



II.



III.

IV.

a. Reis – Buckler dystrophy
b. Granular corneal dystrophy type I
c. Granular corneal dystrophy type II
d. Lattice corneal dystrophy
e. Macular dystrophy
f. Gelatinous corneal dystrophy
g. Congenital hereditary endothelial dystrophy
h. Fuch's endothelial dystrophy

1. I – a, II – g, III – c, IV – d
2. I – e, II – g, III – b, IV – c
3. I – a, II – h, III – c, IV – f
4. I – e, II – h, III – b, IV – d

Ans. 4

In image I: Colloidal iron has been used to stain glycosaaminoglyacans in the corneal stroma – macular corneal dystrophy

In image II: Cornea Guttata (wart like excrescences of Descemet membrane can be seen) – Fuch's endothelial dystrophy

In image III: Hyaline protein is stained bright red with Masson trichrome stain with clear intervening spaces between the deposits – Granular dystrophy Type I

In image IV: Amyloid deposits seen with Congo red stain – Lattice dystrophy

43.

I. Snowflake cataract	a. Hypermetropia
II. Rosette shaped cataract	b. Diabetes Mellitus
III. Morgagnian cataract	c. Blunt trauma
IV. Breadcrumb cataract	d. Penetrating trauma
	e. Hypermature cataract
	f. Myotonic dystrophy
	g. Retinitis pigmentosa

1. I – b, II – f, III – e, IV – g
2. I – b, II – c, III – e, IV – g
3. I – b, II – d, III – a, IV – g
4. I – b, II – d, III – e, IV – a

Ans. 2

44.

I. Inward misdirection of eyelashes	a. Tylosis
II. Inward turning of eyelid margin	b. Madarosis
III. Double row of eyelashes	c. Trichiasis
IV. Loss of lateral 1/3rd of eyelashes	d. Ectropion
	e. Distichiasis
	f. Ankyloblepharon
	g. Entropion

1. I – g, II – c, III – e, IV – b
2. I – c, II – d, III – g, IV – a
3. I – g, II – d, III – e, IV – f
4. I – c, II – g, III – e, IV – b

Ans. 4

45. Visual field defect with the cause.

I. Bitemporal hemianopia	a. Pituitary microadenoma
II. Superior homonymous quadrantanopia	b. 3rd ventricular glioma
III. Junctional scotoma	c. Posterior communicating artery aneurysm
IV. Homonymous hemianopia	d. Meyer's loop
	e. Optic neuritis
	f. Anterior ischemic optic neuropathy
	g. Meningioma

1. I – b, II – d, III – g, IV – c
2. I – a, II – d, III – g, IV – c
3. I – a, II – f, III – e, IV – d
4. I – b, II – f, III – g, IV – d

Ans. 1

46. Laser used in the given ocular conditions.

I. Proliferative diabetic retinopathy	a. Excimer laser
II. Posterior capsulotomy	b. Nd:YAG laser
III. LASIK	c. Nd:Glass laser
IV. Femtosecond laser cataract surgery	d. Helium laser
	e. Argon green laser
	f. CO_2 laser

1. I – f, II – c, III – a, IV – b
2. I – e, II – b, III – d, IV – c
3. I – b, II – e, III – a, IV – f
4. I – e, II – b, III – a, IV – c

Ans. 4

47. Causative genes with the ocular conditions.

I. Aniridia	a. Optineurin
II. Hereditary open angle glaucoma	b. PAX2
III. Retinoblastoma	c. BEST 1
IV. Stargardt's disease	d. PAX6
	e. ABCA 4
	f. CYP4V2
	g. RB1

1. I – b, II – d, III – g, IV – f
2. I – d, II – a, III – g, IV – e
3. I – b, II – a, III – f, IV – c
4. I – d, II – d, III – g, IV – c

Ans. 2

48. Systemic conditions with their ocular manifestations.

I. Hypertensive retinopathy	a. Systemic lupus erythematosus
II. Granulomatous anterior uveitis	b. Sarcoidosis
III. Necrotizing chorioretinitis	c. CMV retinitis
IV. Nuclear pearly cataract	d. Sickle cell retinopathy
	e. Congenital syphilis
	f. Congenital rubella
	g. Giant cell arteritis

1. I – g, II – b, III – e, IV – a
2. I – g, II – b, III – c, IV – f
3. I – a, II – b, III – c, IV – f
4. I – a, II – g, III – e, IV – f

Ans. 3

49. Pathological conditions with pupillary abnormalities seen.

I. Pontine lesions	a. Total afferent pathway defect
II. Topical atropine	b. Marcus Gunn pupil
III. Central retinal artery occlusion	c. Inverse Argyll Robertson pupil
IV. Tabes dorsalis	d. Hutchinson pupil
	e. Pinpoint pupil
	f. Adie pupil
	g. Argyll Robertson pupil
	h. Pharmacological mydriasis

1. I – e, II – f, III – a, IV – g
2. I – e, II – h, III – b, IV – c
3. I – e, II – h, III – d, IV – g
4. I – d, II – f, III – b, IV – c

Ans. 2

50. Phakomatoses with their ocular clinical features.

I. Sturge weber syndrome	a. Optic atrophy
II. Von Recklinghausen disease	b. Myopia
III. Von Hippel-Lindau syndrome	c. Posterior subcapsular cataract
IV. Neurofibromatosis 2	d. Optic glioma
	e. Capillary hemangioblastoma
	f. Glaucoma
	g. Granulomatous uveitis

1. I – f, II – d, III – e, IV – c
2. I – b, II – g, III – a, IV – c
3. I – f, II – a, III – d, IV – b
4. I – b, II – c, III – e, IV – f

Ans. 1

Ref: Parson's 22/e, p. 532

51. Anti-glaucoma drugs with their side effects.

I. Latanoprost	a. Cornea verticillate
II. Timolol	b. Transient myopia
III. Apraclonidine	c. Black conjunctival pigmentation
IV. Pilocarpine	d. Cystoid macular edema
	e. Corneal anaesthesia
	f. Mydriasis
	g. Miosis

1. I – c, II – g, III – f, IV – b
2. I – d, II – e, III – g, IV – a
3. I – d, II – e, III – f, IV – b
4. I – c, II – a, III – g, IV – d

Ans. 3

52. Nerves transmitted through the structures.

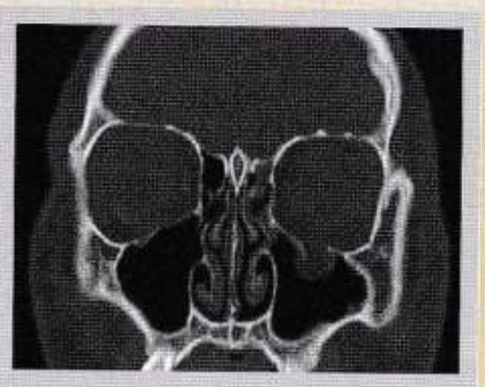
I. Lacrimal nerve	a. Supraorbital foramen
II. Maxillary nerve	b. Upper part of Superior orbital fissure
III. Optic nerve	c. Middle part of Superior orbital fissure
IV. Infraorbital nerve	d. Lower part of Superior orbital fissure
	e. Inferior orbital fissure
	f. Infraorbital foramen
	g. Optic canal

1. I – b, II – d, III – g, IV – f
2. I – c, II – d, III – g, IV – e
3. I – b, II – e, III – g, IV – f
4. I – c, II – d, III – a, IV – e

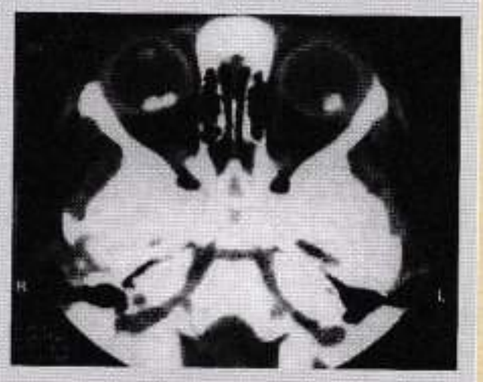
Ans. 3

53. Radiological signs and their causes.

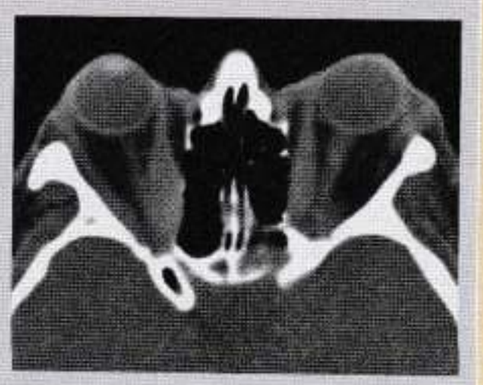
I.



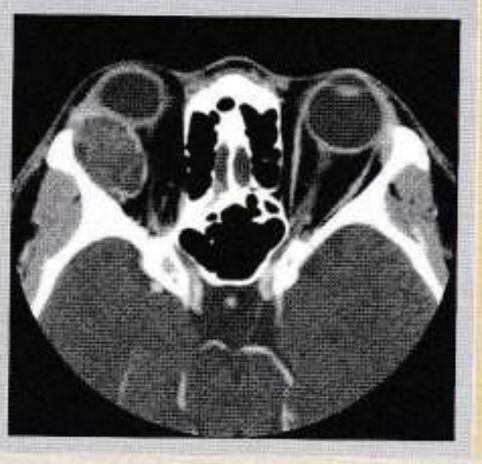
II.



III.



IV.



	a. Le fort fracture
	b. Retinoblastoma
	c. Optic disc drusen
	d. Optic nerve glioma
	e. Thyroid associated orbitopathy
	f. Blow out fracture of orbit
	g. Lacrimal gland tumour

1. I – a, II – c, III – e, IV – g
2. I – f, II – b, III – d, IV – g
3. I – f, II – c, III – e, IV – b
4. I – f, II – b, III – e, IV – g

Ans. 4

Image I: Tear drop sign seen in the left orbit – floor of orbit fracture

Image II: Bilateral calcific growth seen at the retina growing as a mass into the vitreous – Retniblastoma is the most common cause of intraocular calcification

Image III: In TAO – extraocular muscle enlargement is seen and sparing of the anterior tendon, giving a characteristic Coca-cola bottle sign – In the image bilateral Medial rectus enlargement is clearly seen.

Image IV: Lacrimal gland tumour (Adenoid cystic carcinoma), seen as an oval mass superior and lateral to the orbit pushing the eye down and inwards.

54.

I. Levoelevation	a. RLR and LMR
II. Dextroversion	b. RIR and LSO
III. Sursumduction	c. RIR+RSO and LIR+LSO
IV. Dextrodepression	d. LLR and RMR
	e. RSR+RIO and LSR+LIO
	f. RSR and LSR
	g. RSO and LIR
	h. RIO and LSR

1. I – h, II – a, III – e, IV – b
2. I – e, II – d, III – c, IV – b
3. I – e, II – a, III – f, IV – g
4. I – h, II – a, III – f, IV – b

Ans. 1

Pairs of yoke muscles. Please refer in Chapter 3.

55.

I. Fleischer's ring	a. Keratoconus
II. Paton's line	b. Corneal endothelial graft rejection
III. Ferry's line	c. Flitlering bleb of glaucoma surgery
IV. Wessley ring	d. Pterygium
	e. Wilson's disease
	f. Papilledema
	g. Corneal ulcer
	h. Congenital glaucoma

1. I – e, II – f, III – c, IV – h
2. I – a, II – f, III – c, IV – g
3. I – a, II – b, III – d, IV – h
4. I – a, II – h, III – b, IV – g

Ans. 1

56.

I. Tomato splash fundus appearance	a. Non-ischemic CRVO
II. Berlin's edema	b. CRAO
III. Cattle tracking fundus appearance	c. Ischemic CRVO
IV. Bull's eye maculopathy	d. Stargardt's disease
	e. Best's macular dystrophy
	f. Blow out fracture
	g. Cherry red spot at macula
	h. Purtscher's retinopathy

1. I – a, II – g, III – b, IV – h
2. I – c, II – f, III – b, IV – e
3. I – c, II – g, III – a, IV – d
4. I – c, II – g, III – b, IV – d

Ans. 4

57.

I. Vogt striae	a. Buphthalmos
II. White lines of vogt	b. Stem cells
III. Palisdaes of vogt	c. Posterior uveitis
IV. Vogt-Koyanagi-Harada syndrome	d. Keratoconus
	e. Corneal Lattice degeneration
	f. Lattice degeneration of retina
	g. Panuveitis

1. I – a, II – e, III – c, IV – g
2. I – d, II – f, III – b, IV – c
3. I – d, II – e, III – b, IV – g
4. I – a, II – f, III – b, IV – c

Ans. 3

58.

I. Fuch's endothelial dystrophy	a. Cornea guttata
II. Fuch's Heterochromic iridocyclitis	b. Amsler's sign
III. Dalen fuchs nodules	c. Sarcoidosis
IV. Forster-Fuch spots	d. Myopia
	e. ARMD
	f. Krukenberg spindle

1. I – a, II – b, III – c, IV – d
2. I – f, II – e, III – d, IV – c
3. I – f, II – b, III – c, IV – e
4. I – a, II – c, III – f, IV – d

Ans. 1

59.

I. Phacolytic glaucoma	a. Intumescent cataract
II. Neovascular glaucoma	b. Anterior uveitis
III. Inverse glaucoma	c. CRVO
IV. Angle recession glaucoma	d. Diabetic retinopathy
	e. Blunt trauma
	f. Penetrating trauma
	g. Morgagnian cataract

1. I – a, II – c, III – c, IV – f
2. I – g, II – d, III – f, IV – e
3. I – g, II – d, III – b, IV – e
4. I – g, II – c, III – d, IV – f

Ans. 2

MULTIPLE COMPLETION TYPE QUESTIONS

For all the following questions the MARKING KEY is given below

1. If a, b, c are correct
2. If a and c are correct
3. If b and d are correct
4. If all four (a, b, c, d) are correct

60. Ocular manifestations of Sturge Weber syndrome include

a. Choroidal hemangioma b. Glaucoma
c. Iris heterochromia d. Plexiform neurofibroma

Ans. 1

61. Which of the following ocular conditions are inherited Autosomal Dominant?

a. Angioid streaks b. Retinoblastoma
c. Norrie disease d. Tritanopia

Ans. 3

Ref: Parson's 22/e p. 556

Some Hereditary Ophthalmic Diseases

Disease	Inheritance pattern
General	
Refractive error*	Component ametropia, AR Overall ametropia, multifactorial
Dyslexia*	Multifactorial, AD
Nystagmus*	AD/XD/XR
Anterior Segment	
Lattice corneal dystrophy	AD
Macular corneal dystrophy	AR
Avellino corneal dystrophy	AD
Reis–Bukler corneal dystrophy	AD
Meesman corneal dystrophy	AR
Juvenile glaucoma*	AD/AR
Primary open-angle glaucoma	Multifactorial
Primary congenital glaucoma*	Sporadic/mutation/ AR/AD/AR
Rieger syndrome	
Aniridia*	AD, AR
Non-syndrome congenital cataract*	AD, AR, XR
Ectopia lentis*	Sporadic/AD or rarely AR
Retina	
Retinoblastoma	AD
Kearns–Sayre syndrome	Mitochondrial
Tritanopia	AD
X-linked colour blindness	XR
Blur cone monochromacy*	XR/AR
Total rod monochromacy	AR
Wagner syndrome	AD
Goldmann-Favre syndrome	AD
Angioid streaks	AR
Disciform macular degeneration (Kuhnt–Junius syndrome)	AD
Retinitis pigmentosa*	AR/AD/XR
Congenital stationary night blindness	AR/AD/XR
Norrie disease	XR
Leber congenital amaurosis	AR
Gyrate atrophy	AR
von Hippel–Lindau disease	AD
Ocular albinism	XR
Oculocutaneous albinism*	AR, AD
Neuro-Ophthalmic	
Leber optic atrophy	Mitochondrial
Systemic Malformations	
Neurofibromatosis	AD
Waardenburg syndrome	AD
Stickler syndrome	AD
Marfan syndrome	AD
Down syndrome	Chromosomal trisomy 21

*Heterogeneic disorders with more than one pattern of inheritance: AD, autosomal dominant, AR, autosomal recessive; XR, X-linked recessive; XD, X-linked dominant.

Contd...

62. Which of the following drugs act by increasing the trabecular outflow of aqueous?

a. Latanoprotene bunod b. Latanoprost
c. Betaxolol d. Apraclonidine

Ans. 2

63. Which of the following diseases are covered under Vision 2020 program in India?

a. Cataract b. Diabetic retinopathy
c. Corneal blindness d. Glaucoma

Ans. 4

64. Which of the following tests can be done to diagnose Phoria?

a. Cover test b. Uncover test
c. Hirschberg's test d. Maddox rod test

Ans. 3

65. Ocular manifestations of AIDS include

a. HIV retinopathy b. Conjunctival telangiectasia
c. Kaposi sarcoma d. Glaucoma

Ans. 1

66. **Which of the following statements are true for the ocular condition seen in the image below?**

a. Starts at margin and spreads circumferentially
b. Perforation is a common complication
c. It is a diagnosis of exclusion
d. Topical steroids are mainstay treatment

Ans. 2

Ref: Parson's 22/e p. 210

It is an image showing peripheral marginal ulcer with whitish overhanging margins and a vascularized base (seen in the infero-temporal part of cornea)

It rarely perforates and topical steroids and antibiotics are ineffective.

67. **Which of the following statements are true with regards to congenital ptosis?**
a. Associated with poor levator function
b. Ptotic eyelid lags behind the normal eyelid on downgaze
c. Upper eyelid crease is absent
d. Levator resection is done in cases of severe ptosis with poor levator function

Ans. 1

68. **Which of the following ocular manifestations may be seen in a case of Multiple Sclerosis?**
a. Retrobulbar neuritis
b. Nystagmus
c. RAPD
d. Internuclear ophthalmoplegia

Ans. 4

Ref: Parson's 22/e p. 526

69. **Which of the following ocular manifestations may be seen in Tabes Dorsalis?**
a. Internal ophthalmoplegia
b. Argyll Robertson pupil
c. Optic atrophy
d. Papilledema

Ans. 1

Ref: Parson's 22/e p. 524-525

70. **Which of the following is not true for Cavernous sinus thrombosis?**
a. IIIrd cranial nerve is the earliest affected
b. IIIrd, IVth, VIth, maxillary and ophthalmic nerves are affected
c. Almost always unilateral presentation
d. High grade fever and pain at present at the onset

Ans. 2

71. **Intermediate uveitis involves inflammation of**
a. Iris
b. Pars plana
c. Pars plicata
d. Vitreous

Ans. 3

72. **Which of the following are causes of congenital corneal opacification?**
a. Mucopolysaccharidosis
b. Sclero-cornea
c. Trauma
d. Peter's anomaly

Ans. 4

Ref: Parson's 22/e p. 221

73. **Which of the following are true about abducens nerve palsy?**
a. Most common congenital paralytic squint
b. Primary deviation is always less than secondary deviation
c. Can be diagnosed on Forced duction test
d. Presents with ipsilateral esotropia

Ans. 3

74. **Which of the following are true about head posture seen in cases of superior oblique palsy?**
a. Face turn towards the opposite side
b. Chin depression
c. On head tilt, hypertropia becomes better in the opposite eye
d. On head tilt, hypertropia becomes worse in the opposite eye

Ans. 1

75. **Which of the following can lead to Pseudoesotropia?**
a. Positive angle kappa
b. Telecanthus
c. Wide Inter-pupillary distance
d. Euryblepharon

Ans. 2

76. **Which of the following diseases are associated with Non-granulaomatous uveitis?**
a. UGH syndrome
b. Fuchs heterochromic iridocyclitis
c. Idiopathic
d. Ankylosing spondylitis

Ans. 4

Ref: Parson's 22/e p. 235

77. **Which of the following investigations should be done in case of a bilateral, non-hereditray paediatric cataract?**
a. Urine assay for reducing substances
b. CT scan of the orbit
c. Serology
d. Karyotyping

Ans. 2

Ref: Parson's 22/e p. 273

78. **Which of the following conditions lead to rhegmatogenous retinal detachment?**
a. Penetrating trauma
b. Pathological myopia
c. Choroidal melanoma
d. Diabetic retinopathy

Ans. 3

79. **Which of the following are indications for vitrectomy?**
a. Long standing vitreous hemorrhage
b. Paediatric cataract
c. Rhegmatogenous retinal detachment with proliferative vitreoretinopathy
d. Exudative retinal detachment

Ans. 1

Ref: Parson's 22/e p. 345

ASSERTION AND REASON TYPE

Each question shall have 2 statements:
Assertion (A)
Reason (B), connected by the term 'because'.

The answers should be marked using the following key:
1. Both assertion and reason are independently true statements and the reason is the correct explanation for the Assertion
2. Both assertion and reason are independently true statements, but the reason is not the correct explanation for the assertion
3. Assertion is independently true statement, but the reason is independently false statement
4. Assertion is independently false statement, but the reason is independently true statement
5. Both assertion and reasoning are independently false statements

80. **A:** 'Second sight' is seen in cases of Nuclear cataract
B: Change in the refractive index of nucleus causes index myopia, improving near vision

Ans. 1

81. **A:** 'Second sight' is seen in cases of Nuclear cataract
B: Blue end of the spectrum is more absorbed by the cataractous lens

Ans. 2

82. **A:** 'Second sight' is seen in cases of Nuclear cataract
B: Decreased scattering of light occurs

Ans. 3

83. **A:** 'Second sight' is seen in cases of cortical cataract
B: Change in the refractive index of nucleus causes index myopia, improving near vision

Ans. 4

84. **A:** 'Second sight' is seen in cases of cortical cataract
B: Decreased scattering of light occurs

Ans. 5

Explanations for Q80 to Q84.
Ref: Parson's 22nd/265

The 5 questions have been given as variations of each other to make the student understand how the examiner can ask various A and R questions on the same topic/statement, but the answer may be different.

Second sight is seen in Nuclear cataract, as due to nuclear sclerosis, refractive index of lens increases thereby leading to Myopia i.e. Near sightedness, and hence the near vision improves in the patient who was expectedly already presbyopic (>40 years of age).

Cortical cataract presents with increased scattering of light leading to Glare.

85. **A:** In Immature cataract, when light is thrown from temporal side it casts a shadow over the nasal iris
B: There is clear lens substance between pupillary margin and the opacity in the lens

Ans. 4

In Immature cataract, shadow is cast by the iris on the opaque lens surface as there is a clear part of lens between the pupillary margin and the opacity in the lens.

86. **A:** Cupuliform cataract causes most severe loos of vision
B: Opacity is present at the nodal point of eye

Ans. 1

87. **A:** Colored halos are commonly seen in acute angle closure glaucoma
B: Prismatic dispersion of light

Ans. 1

88. **A:** Floaters are common in young myopes
B: With increasing age, vitreous gel liquefies

Ans. 2

Floaters are usually due to vitreous degeneration and liquefaction and are age related, but they are also commoner in

young age in myopes. Both the statements are correct but no an explanation for the given assertion.

89. **A:** Patient perceives flashes of light
B: Vitreous liquefaction leads to pull on vitreoretinal attachments irritating the retina causing it to discharge electrical signals

Ans. 1

90. **A:** Pseudo-Esotropia is associated with Hypermetropia
B: Angle kappa is negative in hypermetropes

Ans. 5

Pseudoesotropia is seen in cases of high myopia, as Negative angle kappa (<50) is formed due to a nasal fovea

91. **A:** Photophobia is encountered in patients with Posterior subcapsular cataract.
B: Posterior subcapsular cataract produces excessive irregular scattering of light in the eye

Ans. 4

Glare is encountered in patients of PSC (assertion is false statement) due to the above stated reason.
Photophobia is instead seen in conditions like anterior uveitis because of the pain produced due to ciliary spasm.

92. **A:** Cherry red spot at the macula is seen in Central retinal artery occlusion
B: Cilioretinal arteries supply the macula and escape occlusion

Ans. 3

Cherry red spot at macula is seen in CRAO, due to collection of fluid in Ganglion cell layer of retina which is absent/very thin at the fovea centralis, thus, red colour of the choroid is still visible at there in contrast to the surrounding macula/ retina which becomes milky white and opaque due to edema, obscuring the choroidal red reflex.

93. **A:** If eye moves outwards on Uncover, it is a case of Divergent squint
B: Eye was deviated outwards and had to move in pick up fixation

Ans. 4

If eye move INWARDS, it is a case of divergent squint, as the outward deviated eye moves in to pick up fixation on Uncover

94. **A:** Bell's phenomenon should be assessed preoperatively in ptosis surgery.
B: Poor Bell's phenomenon after surgery could result in exposure keratitis during sleep

Ans. 1

95. **A:** Distant vision is relatively spared in cases of mixed astigmatism
B: Curvature of nucleus of lens is greater than the periphery of lens

Ans. 2

Distant vision is relatively spared in cases of mixed astigmatism because the circle of least diffusion falls at or very near to the retina
Reason is also a correct statement but not an explanation for the given assertion.

96. **A:** Binocular visual acuity is usually better than each eye tested separately
B: Cortical summation of the visual input occurs from both the eyes.

Ans. 1

97. **A:** Optic neuritis presents with Anisocoria
B: Optic neuritis usually presents with unilateral blindness

Ans. 2

Optic neuritis usually causes Unilateral loss of vision and thus, the pupil are always of the same size (isocoria) and never presents with dilated pupil as consensual light reflex is elicited by light on normal fellow eye

98. **A:** The readings from Schiotz tonometer are largely accurate
B: Variations occur in the corneo-scleral rigidity

Ans. 4

Readings from Schiotz tonometer are largely inaccurate because of the stated reason.

99. **A:** Diffuse nebular opacity interferes more with vision
B: Iris details cannot be seen through it

Ans. 3

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1

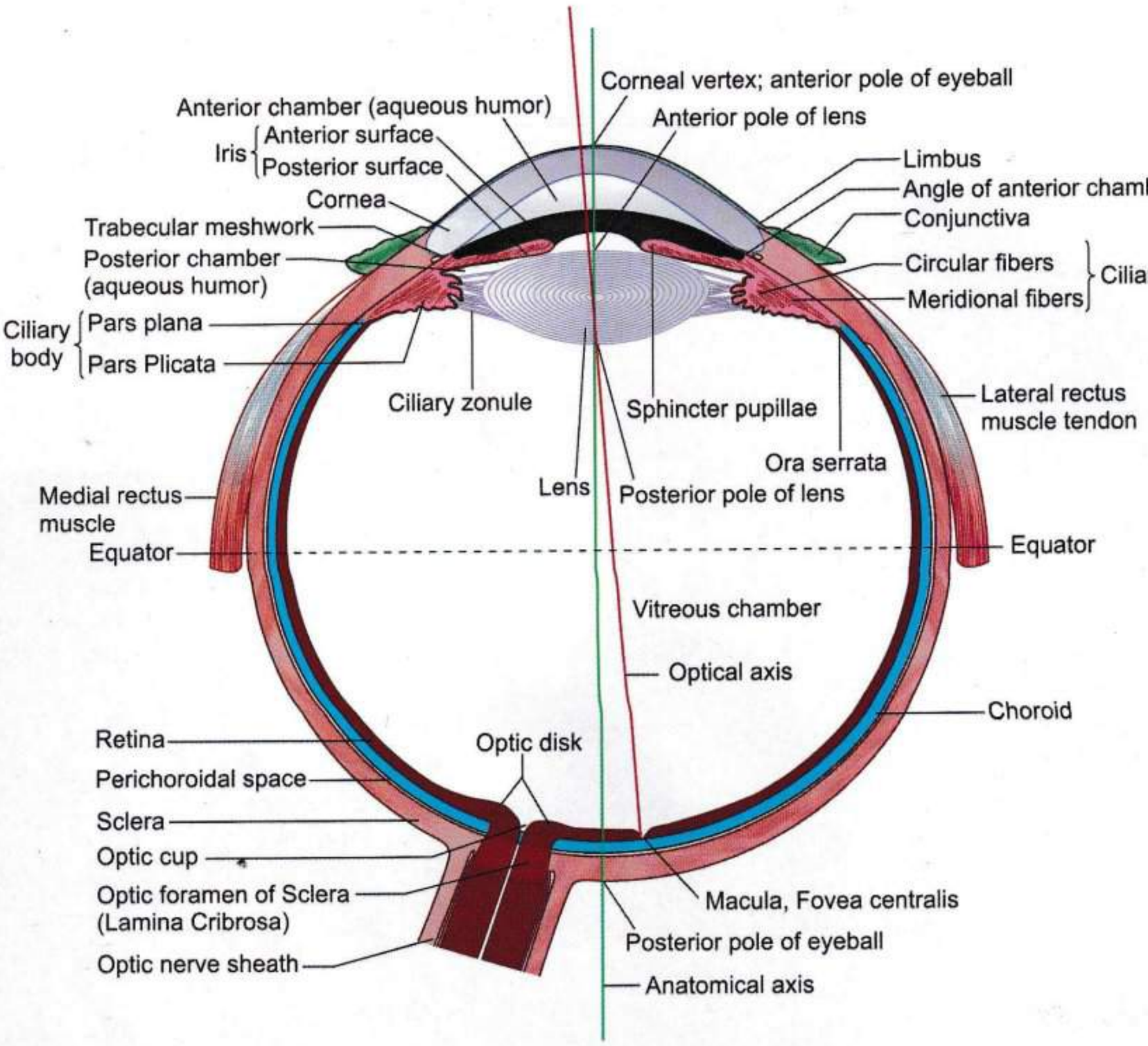
ANATOMY OF EYE

Chapter Outline

Anatomy of Eye
- Coats of the Eyeball
- Segments and Chambers of the Eyeball
- Blood Supply of the Eye
  - Blood-Ocular Barrier

Embryology of Eye
- Congenital Malformations
  - Coloboma
  - Defects of Neural Crest Cells
  - Aniridia

ANATOMY OF EYE



Sagittal section of the eye

- The shape of the eyeball is **Ablate spheroid**.
- The volume of eyeball is 6 mL.
- The **axial length** of eyeball (anteroposterior diameter) is **24 mm**.[Q]

Coats of The Eyeball

There are 3 coats/layers to the eyeball

- **Outermost coat** (fibrous coat of the eyeball)
  - Anterior 1/6th – Cornea (transparent)
  - Posterior 5/6th – Sclera (opaque)
  - Corneoscleral junction – Limbus
- **Middle coat** – Uveal tract (vascular coat of the eyeball) consists of Iris anteriorly, Ciliary body (consists of Pars plicata anteriorly and Pars plana posteriorly) and Choroid
- **Innermost coat** – Retina (neural coat of the eyeball)

(Note that the innermost layer is an incomplete layer in that it doesnot line the anterior part of the eye)

Ora Serrata

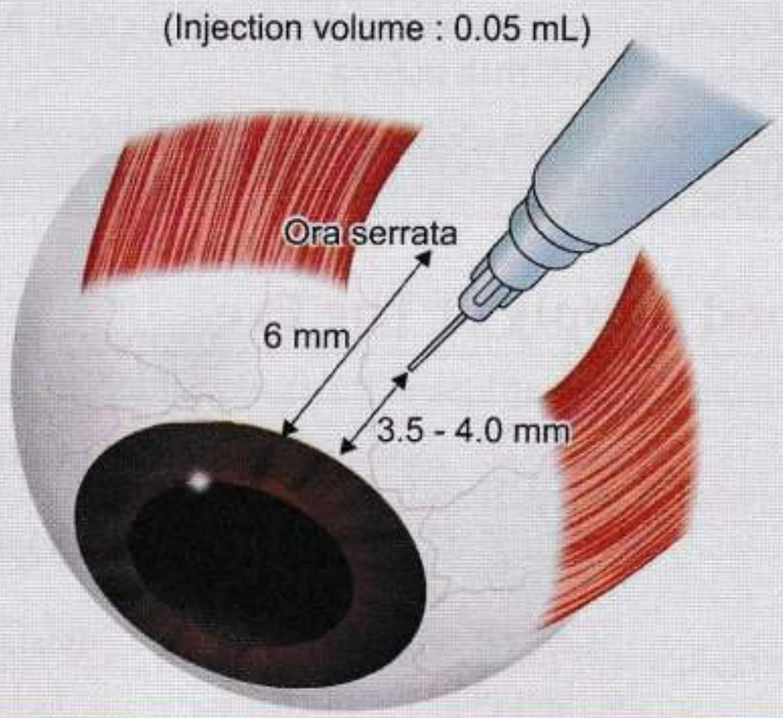
- It is the **junction** between the ciliary body and choroid

  or

  It is the **point of anterior termination of retina**
- **Topographically**, it represents the insertion of Medial rectus and Lateral rectus muscle
- Its anatomical significance is to determine the **site of Intravitreal (IVT) injection**. The point of penetration should be anterior to the Ora serrata (as posteriorly from the ora serrata, retina is present)

  Thus, the **site for IVT injection is**
  - Anterior to Ora serrata
  - Posterior to Limbus
  - By piercing Sclera and the Pars plana (ciliary body starts 1 mm from the limbus and extends posteriorly 6 mm up to ora serrata. The first 2 mm comprise the Pars pliacta and the posterior 4 mm comprise the Pars plana

The distance between Ora serrata and limbus is **6 mm** (slightly more anterior on the nasal side)



Exact distance of IVT injection depends upon the status of lens

3 mm posterior to Limbus – **Aphakia** (absence of lens)

3.5 mm posterior to Limbus – **Pseudophakia** (presence of Intraocular Lens – IOL, as after cataract surgery)

4 mm posterior to Limbus – **Phakia** (normal crystalline lens)

Segments and Chambers of The Eyeball

Anterior segment
(Part of eye which is anterior to the posterior border of lens)

Anterior chamber (AC)
(Space between the posterior surface of cornea and the iris)

Posterior chamber (PC)
(Triangular space between the posterior surface of iris and lens)

Contains Aqueous humour

Posterior segment
(Part of the eye which is posterior to the posterior border of lens)

Contains Vitreous humour

Aqueous	Vitreous
Volume – 0.31 mL (0.25 mL in AC and 0.06 mL in PC)	Volume – 4 mL
Present in a liquid state	Present in a Gel state (due to presence of **Hyaluronic acid**)[Q]
Rate of production – 2.3 µL/min	Not produced continuously throughout life
Exerts Intraocular pressure (IOP)	Maintains shape of the eyeball

HIGH YIELD

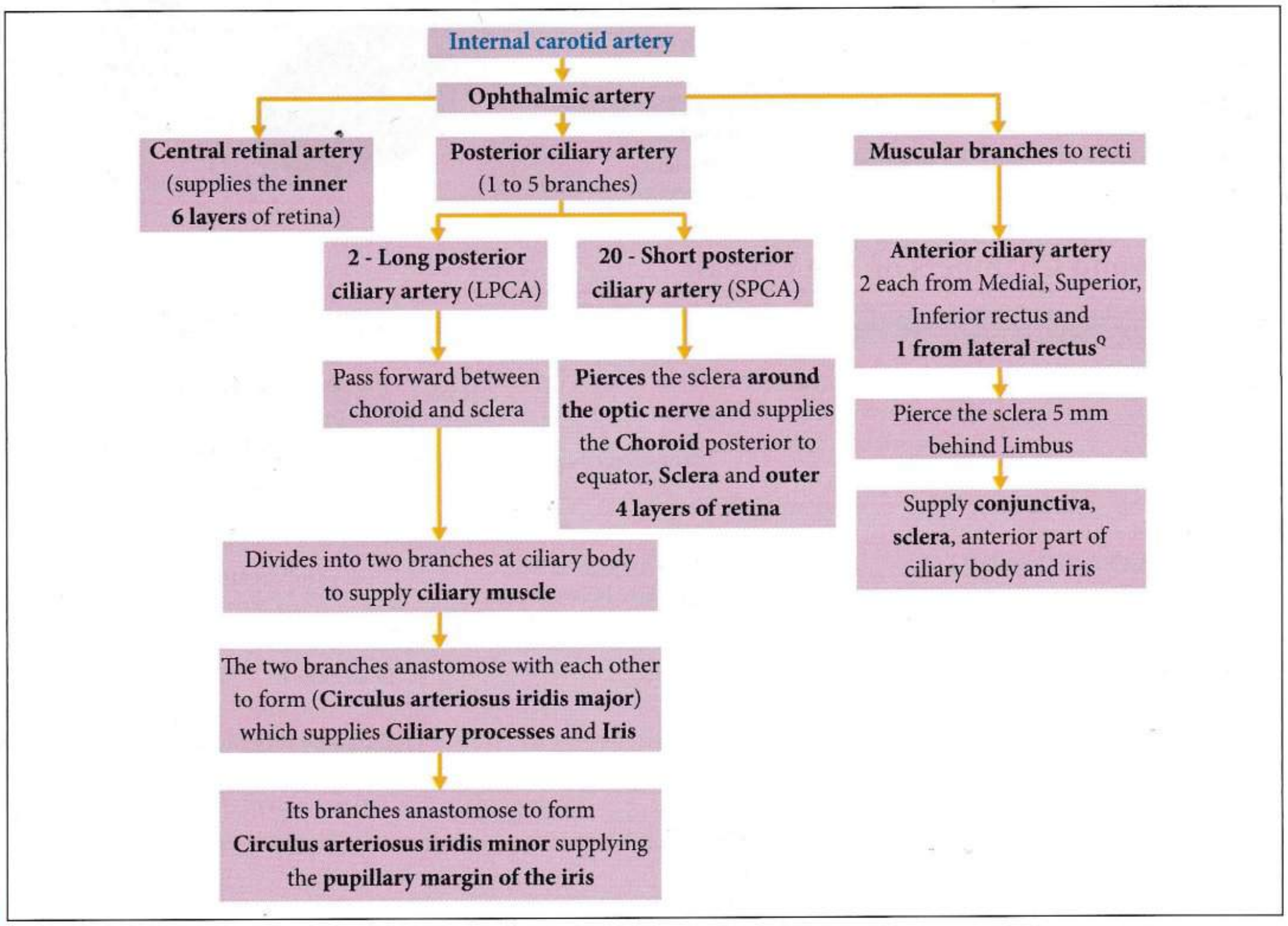
- The depth of AC is genetically determined with a Dominant inheritance.
- **AC is about 3 mm deep (2.5-4.4 mm)**, being shallower in elderly, females and hypermetropes and **deeper** in **y**oung, **m**ales and **m**yopes (Remember as My My)
- The peripheral recess of the AC is known as angle of anterior chamber – the site of aqueous outflow
- Aqueous contains higher levels of **L**actate, **A**scrobate and **P**yruvate **(LAP)** than plasma
- Aqueous contains lower levels of Proteins, urea and glucose than plasma

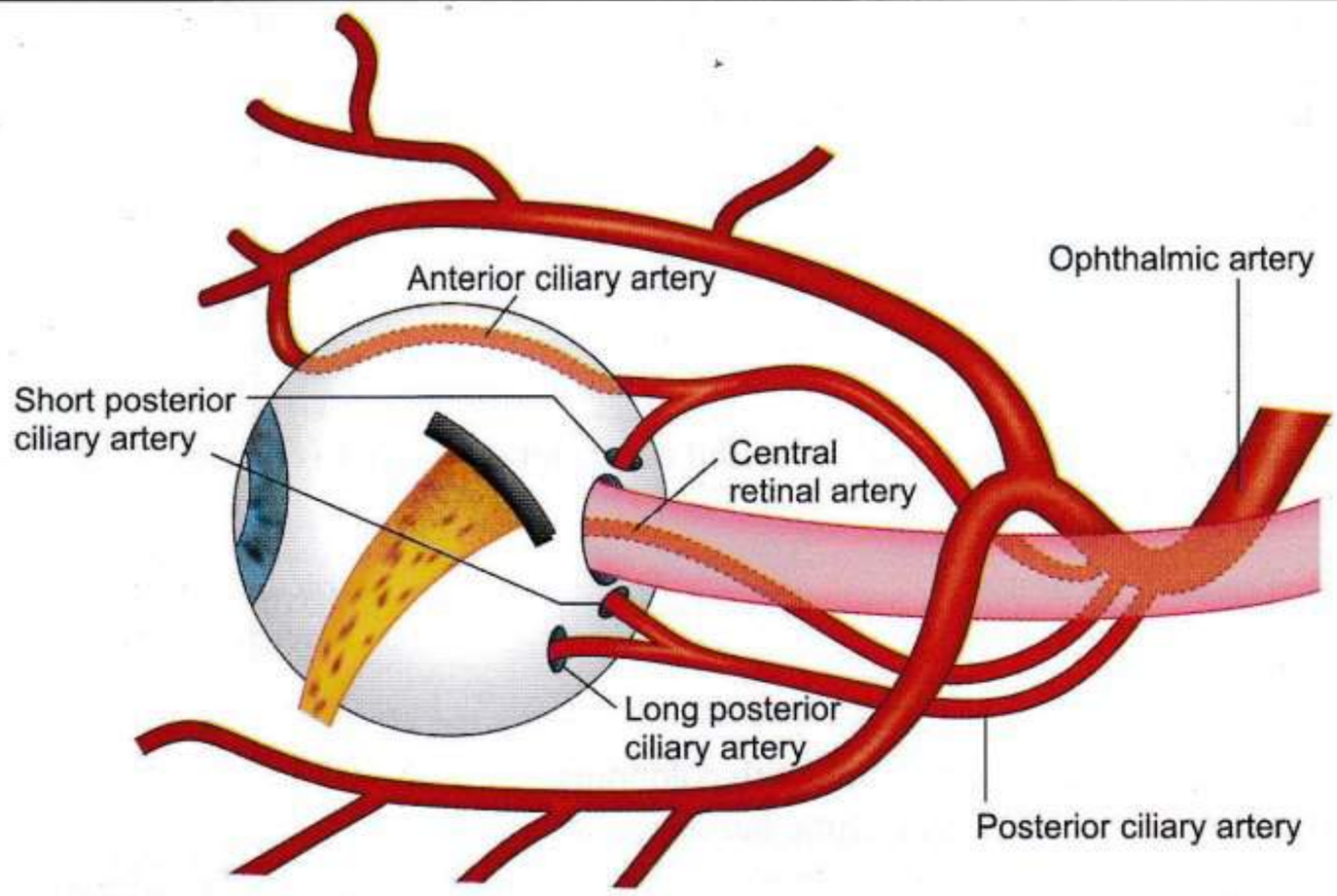
Fundus

Is fundus a part of the eye, is it the retina or some part of the retina???

Fundus **is a VIEW, of the structures which comprise the posterior segment of the eyeball**, i.e. a view of the transparent Vitreous, transparent Retina and the choroid (most vascular part of the eye – red colour). Thus, owing to the vascularity of choroid, fundus gives a Red reflex when light is shone on it

Blood Supply of The Eye


Internal carotid artery
Ophthalmic artery
Central retinal artery (supplies the inner 6 layers of retina)
Posterior ciliary artery (1 to 5 branches)
2 - Long posterior ciliary artery (LPCA)
20 - Short posterior ciliary artery (SPCA)
Pass forward between choroid and sclera
Pierces the sclera around the optic nerve and supplies the Choroid posterior to equator, Sclera and outer 4 layers of retina
Divides into two branches at ciliary body to supply ciliary muscle
The two branches anastomose with each other to form (Circulus arteriosus iridis major) which supplies Ciliary processes and Iris
Its branches anastomose to form Circulus arteriosus iridis minor supplying the pupillary margin of the iris
Muscular branches to recti
Anterior ciliary artery 2 each from Medial, Superior, Inferior rectus and 1 from lateral rectus[Q]
Pierce the sclera 5 mm behind Limbus
Supply conjunctiva, sclera, anterior part of ciliary body and iris



Blood supply of the eye

Blood-Ocular Barrier

The Blood-Ocular barrier prevents the proteins and other large molecular size substances from entering the eye. It consists of 2 parts

- **Anterior blood aqueous barrier** – formed by the tight junctions (Zonula occludens and Zonula adherans) between the cells of the **inner non-pigmented epithelium of the ciliary body**[Q]
- Posterior blood retinal barrier
  - **Inner**[Q] – tight junctions of retinal capillaries and endothelial cells (between inner nuclear layer and outer plexiform layer of retina)
  - **Outer**[Q] – tight junctions between adjacent **Retinal pigment epithelium cells**; Bruch's membrane and fenestrated endothelium of the choriocapillaris

EMBRYOLOGY OF EYE

Various structures in the eye are formed from different germ layers as given below

Surface Ectoderm	Neuroectoderm	Neural crest cells	Mesoderm
Skin of the eyelids	Optic nerve	Melanocytes	Extraocular muscles - 7
Epithelium of conjunctiva	Retina[Q]	Sclera[Q]	Connective tissue
Epithelium of cornea	Part of secondary vitreous	Ciliary muscle[Q]	Temporal part of Sclera
Tarsal glands	Epithelium of ciliary body	Stroma of iris and ciliary body	Endothelial lining of blood vessels
Lacrimal gland	Epithelium of iris	Sheaths of the optic nerve	
Crystalline **lens**[Q]	**Smooth muscles of iris**[Q] – dilator and sphincter pupillae	Bowman layer, stroma, descement membrane of cornea	
		Trabecular meshwork	

- Development of eye begins at the end of 3rd week of gestation, around **Day 22**
- **Retina** develops from the **optic cup** – Outer layer of cup forms the outermost layer of retina – Pigment epithelium and inner layer of optic cup forms the Neurosensory retina
- Anterior end of the **optic cup** differentiates into **epithelium of iris and ciliary body** and the smooth muscles of iris
- **Lens** is formed by the lens placode and the lens vesicle

- **Mesenchyme derived from neural crest** differentiates into a superficial fibrous layer forming sclera and cornea and deep vascular layer forming the Uveal tract
- Tunica vasculosa lentis – gives nourishment to lens during development.

Congenital Malformations

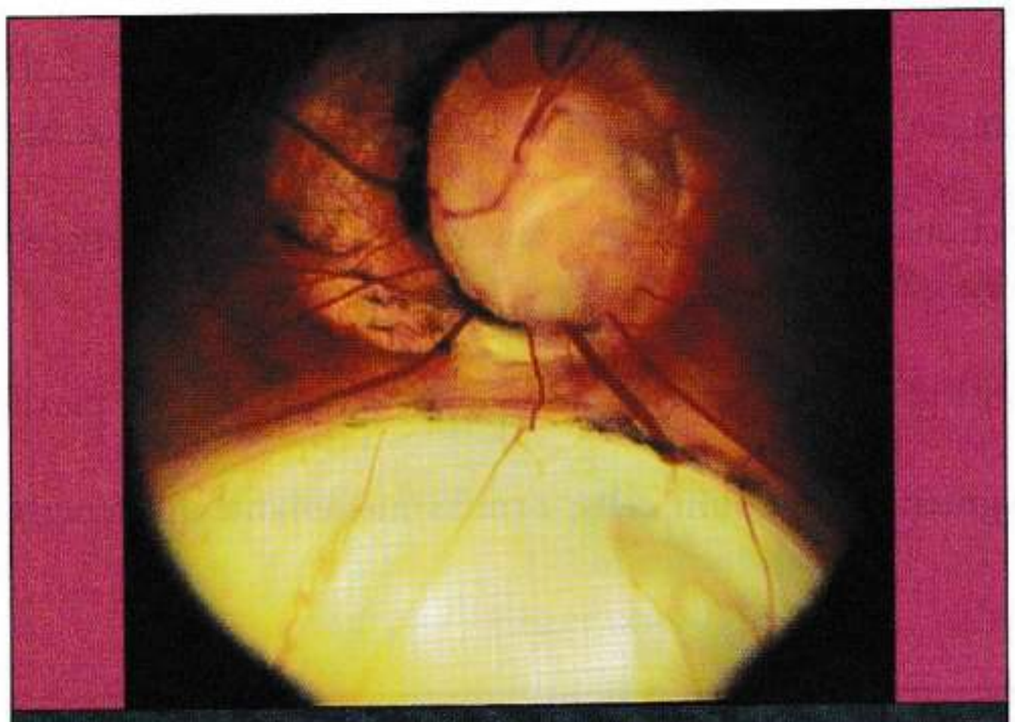
Coloboma

Congenital malformation due to **failure of the choroidal or the fetal fissure to close** by 6th or 7th week of gestation

Typical Coloboma Inferonasal quadrant	Atypical Coloboma Anywhere else

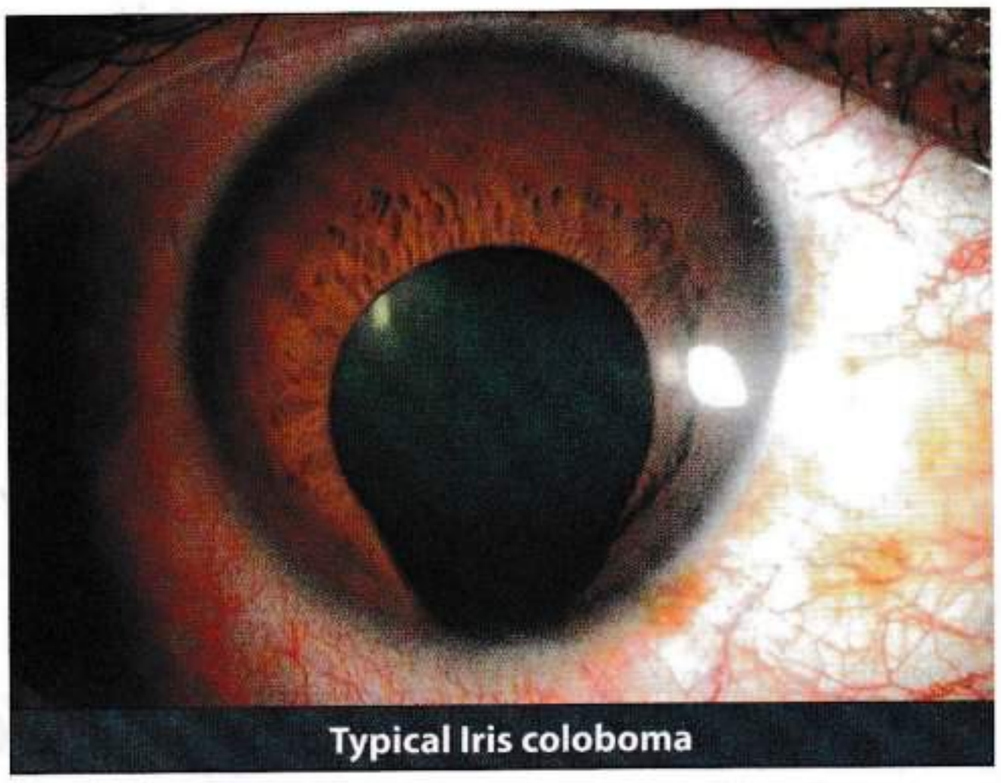
Usually isolated Iris Coloboma but may be associated with coloboma of Ciliary body, Ciliary zonules, choroid, Retina, Optic nerve, eyelid

LENS COLOBOMA is not a True Coloboma



Choroidal coloboma

White sclera visible where the choroid has not developed

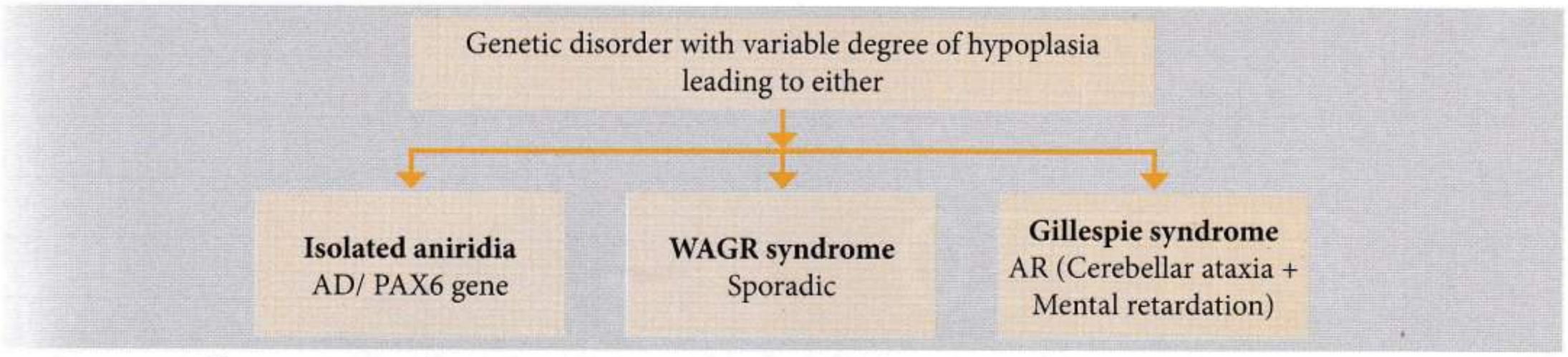


Typical Iris coloboma

Defects of Neural Crest Cells

Defects of neural crest cell migration				Defects of neural crest cell proliferation	Defects of neural crest cell differentiation
	Wave Abnormality			Irido-corneal endothelial syndrome (Read in Ch. 6)	Congenital hereditary endothelial dystrophy (CHED) (Read in Ch. 13)
	1	2	3		
Peter's anomaly	X		X		
Axenfeld-Rieger syndrome	X		X		
Sclerocornea		X			
Posterior embryotoxon	X				

Aniridia



- **Presents with** a narrow rim of iris tissue existing at the ciliary border, not a total absence of iris tissue
- Usually bilateral
- **Associated with** foveal hypoplasia, **glaucoma** (2°ACG) cataract and pannus.
- Patient has poor visual acuity with nystagmus and strabismus.

Aniridia – note the partially remaining iris tissue

NOTES

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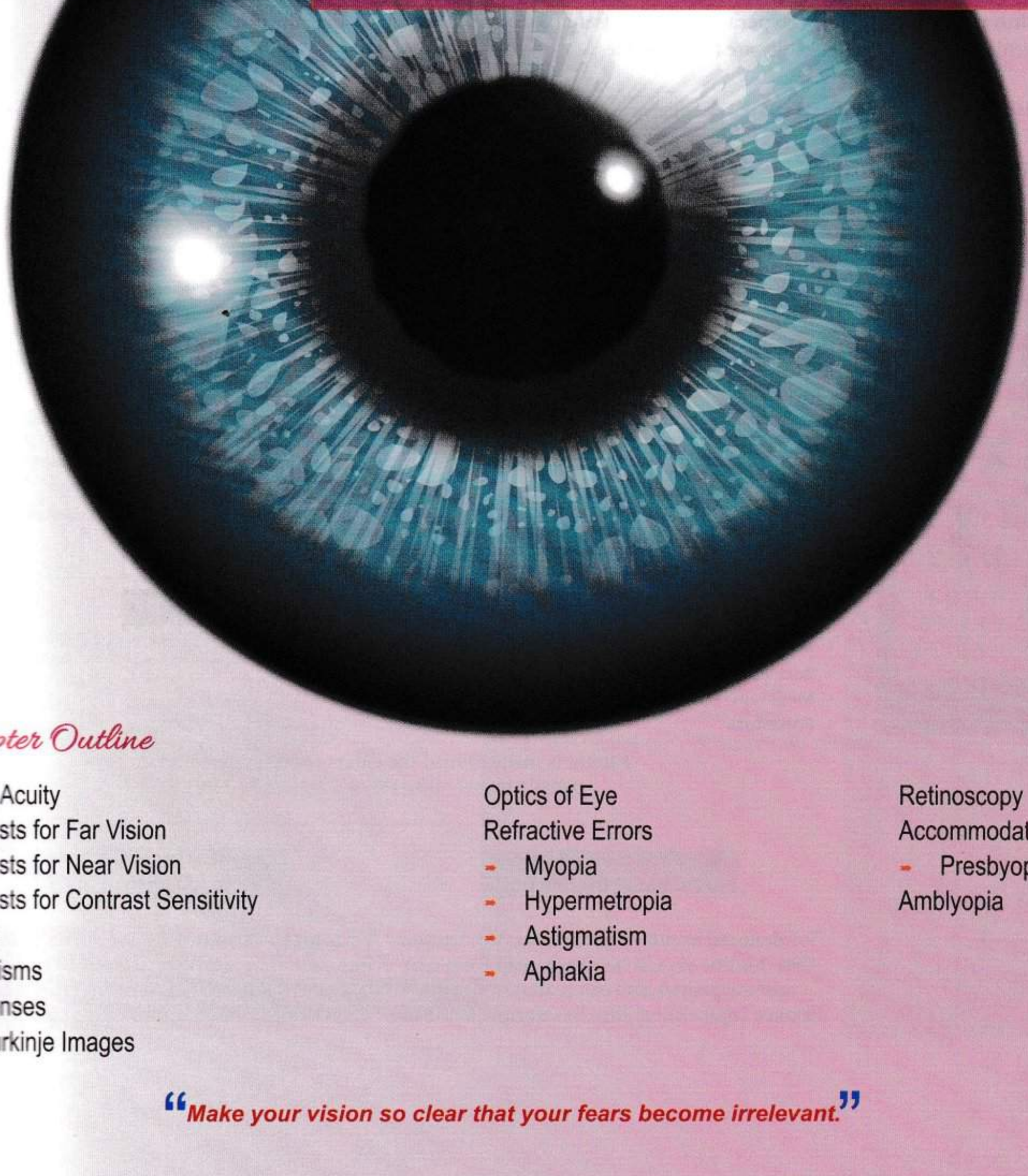
OPTICS



Chapter Outline

Visual Acuity
- Tests for Far Vision
- Tests for Near Vision
- Tests for Contrast Sensitivity

Optics
- Prisms
- Lenses
- Purkinje Images

Optics of Eye

Refractive Errors
- Myopia
- Hypermetropia
- Astigmatism
- Aphakia

Retinoscopy

Accommodation
- Presbyopia

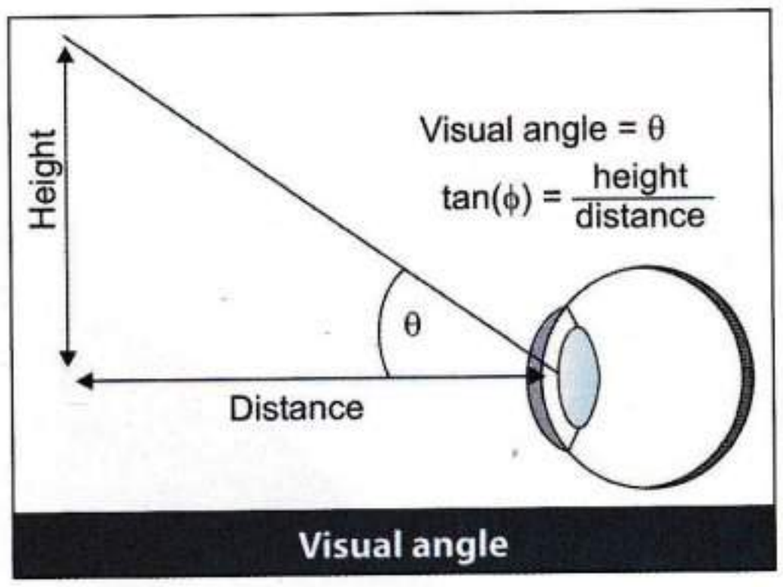
Amblyopia

"Make your vision so clear that your fears become irrelevant."

VISUAL ACUITY

Visual acuity (VA) is a measure of the spatial resolution of the eye or the reciprocal of the minimum resolvable visual angle or simply put, the estimation of the eye's ability to discriminate (see seperately) between two points.

Visual angle: It is the angle subtended at the nodal point of the eye by the physical dimensions of an object in the visual field.



Visual angle

Visual Acuity Components

- **Minimum visible:** Stimulus present or absent in visual field (detection acuity)
- **Minimum resolvable and recognizable:** Separation between two points such that they are seen separately.
  - **Minimum angle of resolution (MAR)[Q] is 30–60 second of arc.**
  - Foveal cones are separated by 30 second of arc (2 microns).
  - For MAR, 2 points should leave one cone unstimulated between two stimulated cones.
- **Minimum discriminable (Hyperacuity):** An offset of 3–5 seconds of arc is normally discernible. Vernier acuity and Stereoacuity are two examples.

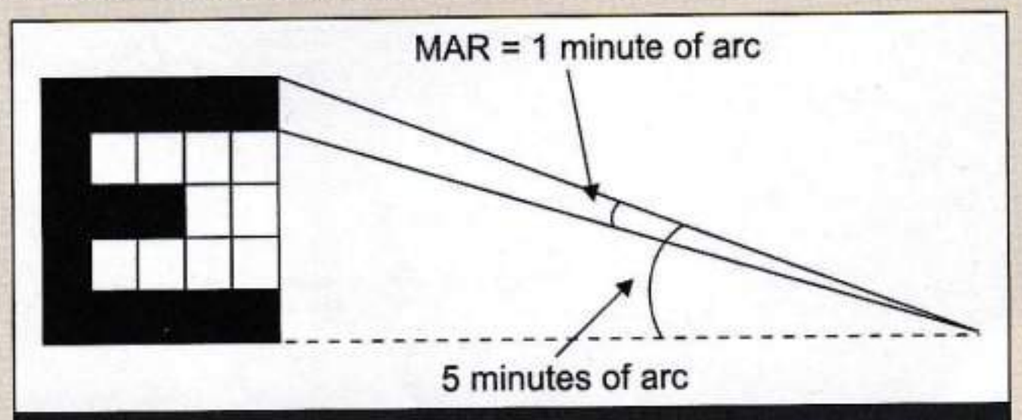
Visual Acuity Measurement

Tests for Far Vision

Adults

Snellen's chart

- It is a letter identification test
- It **measures minimum resolvable VA**[Q]
- **Principle:** It consists of letters arranged in lines, with progressively diminishing size.
  Each letter subtends an angle of **5 minutes** at the nodal point of eye **when viewed from its respective distance**[Q]
  Each letter is so constructed that the width (of each stroke) subtends an angle of 1 minute = MAR



Topmost letter when viewed from 60 m

- Normal visual acuity for far is 6/5
- Best visual acuity for far is 6/3
- Minimum recordable VA on Snellen's chart is 1/60
- **Procedure**

Patient is made to read the letters from top downward usually from a distance of 6 meters / 20 feet

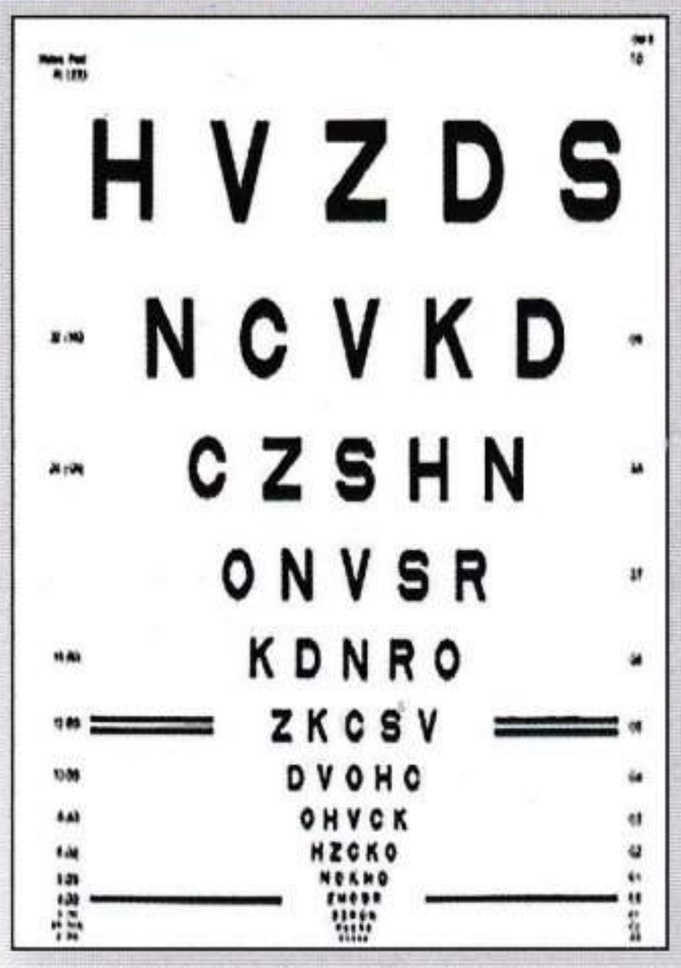
If patient reads all letters from top to the 6 m line

VA denoted as 6/6 - denominator (6) denotes that this line should be clearly read from 6 m and the patient also can read it from 6 m distance (numerator) thus has normal far vision

If patient reads all letters from top to 18 m line

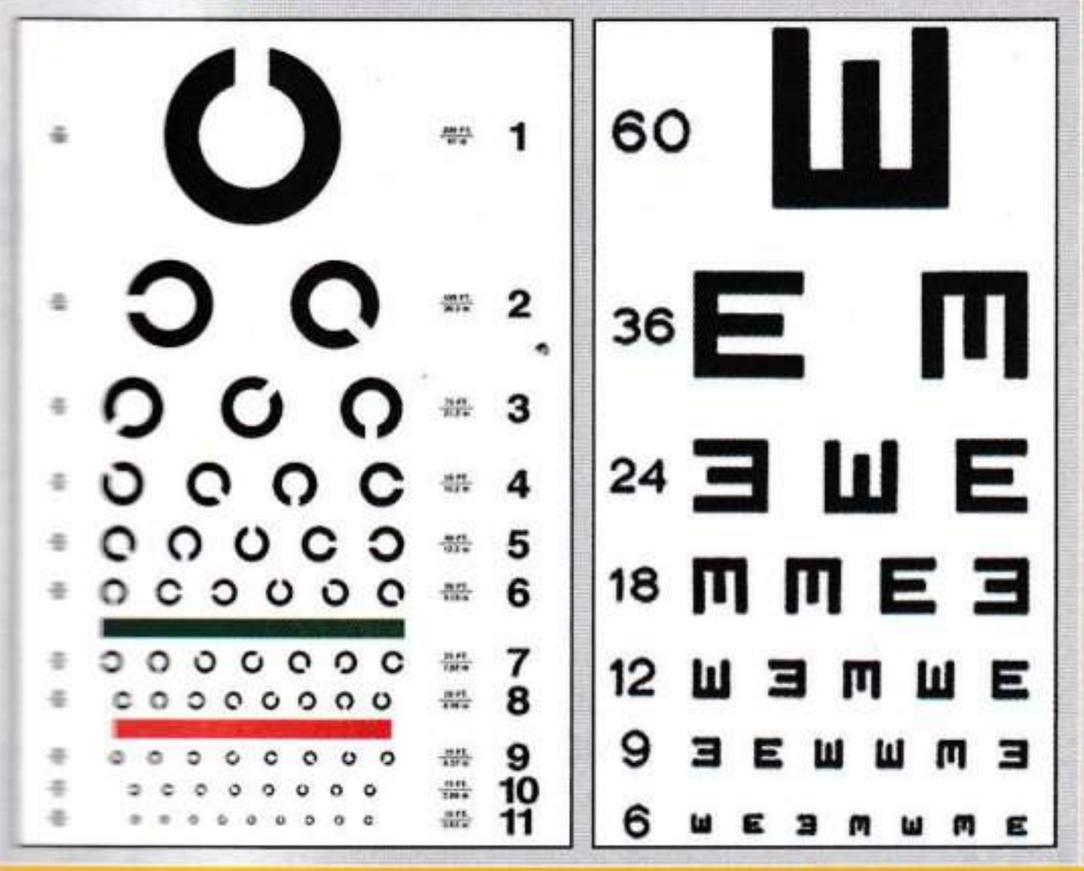
VA is 6/18 - denominator (18) denotes that this line should be clearly read from 18 m distance, but the patient reads it from 6 m distance (numerator) thus has dimunition of far vision

Log MAR charts[Q] – Bailey love and ETDRS chart



- Chart designed on logarithmic basis
- 5 letters in each row with 5:4 structure (height : breadth)
- Spacing between letters and rows proportional to letter size
- Each letter given a scoring

Landolt's C ring test and Snellen's E-chart test



- It is of use **in illiterate adults**
- Same procedure and construction as Snellen's chart, but consists of C (broken circles) or E instead of alphabet letters.

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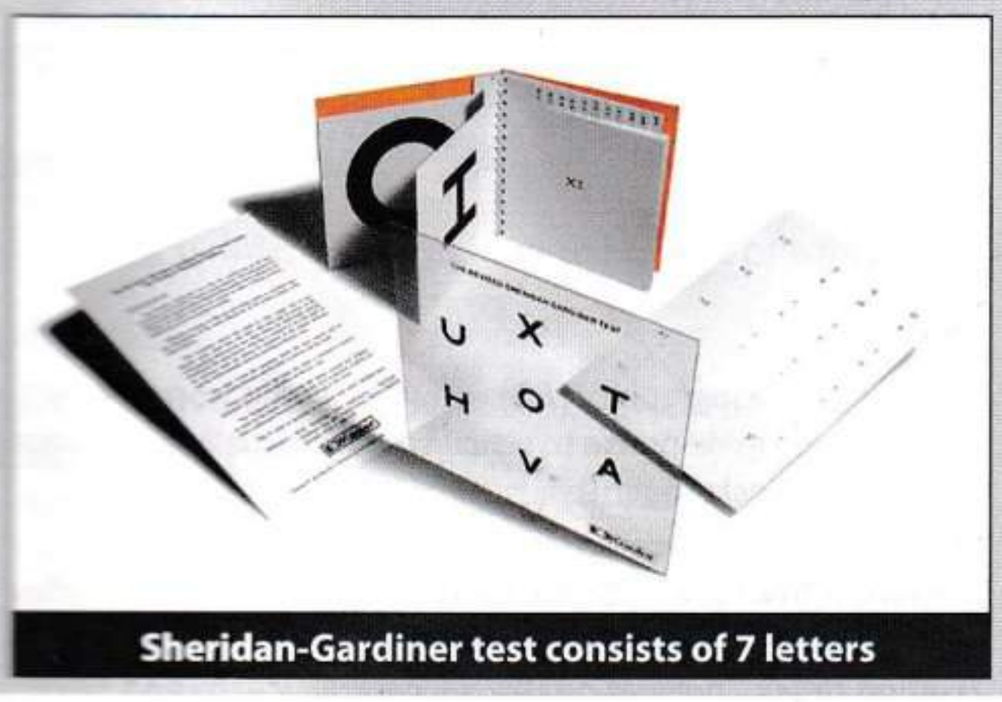
Patient identifies direction of opening of circle or open side of E, thus, **direction identification test**.

Verbal Pre-school Children (2–5 years)

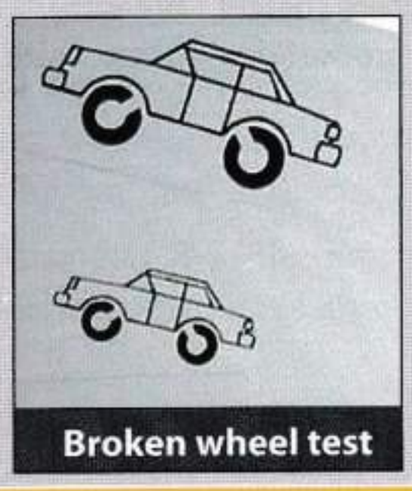
Based on matching/naming of letter optotype (3–5 years)



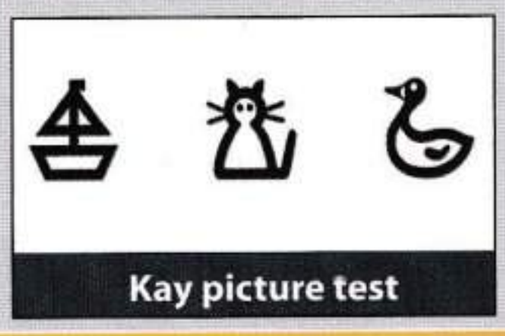
Sheridan-Gardiner test consists of 7 letters

- Illiterate E cut out test
- Tumbling E test
- Sheridan-Gardiner HOTV test
- Keeler log MAR crowded test
- STYCAR test – Screening test for young children and retards

Based on matching/naming picture symbol optoptye (2-3 years)



Broken wheel test

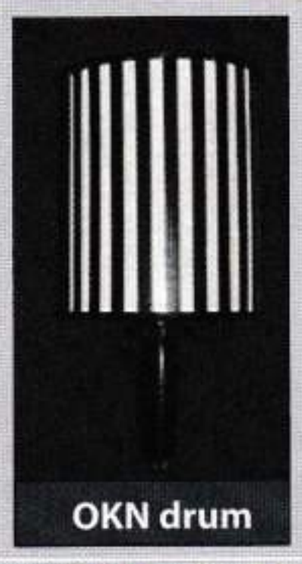


Kay picture test

- Sjögren's hand-figure test
- Kay picture test
- Allen Pre-school test
- Light house test
- Broken wheel test

Infants

Optokinetic nystagmus (OKN test)



OKN drum

Catford drum

- Nystagmus is elicited by passing a succession of black and white dots or strips in the infants visual field
- Can be done using
  - OKN drum – resolution acuity
  - Catford drum – detection acuity

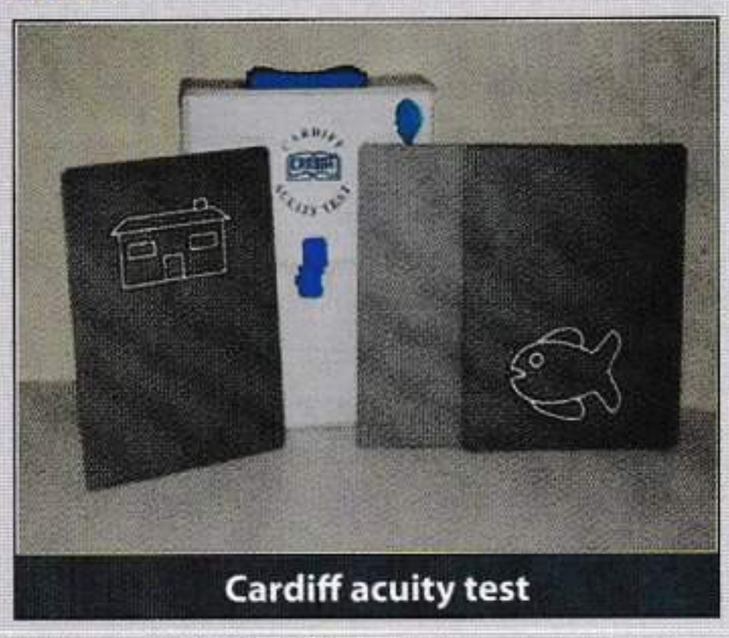
Preferential Looking Test (PLT)

Teller Acuity cards

Keeler gratings

- An infant prefers to look at a striped pattern when presented with two adjacent stimulus fields, one striped and the other homogenous.
- Test can be done by
  - Teller acuity cards
  - Keeler gratings

Cardiff Acuity Test



Cardiff acuity test

- It is a vanishing optotype test
- It can be used in **infants and toddlers**

Other tests for toddlers (1–2 years)

- Hundred and thousand sweet test
- Dot visual acuity test
- Worth's Ivory ball test
- Cardiff acuity test

Visual evoked potential (VEP)[Q]

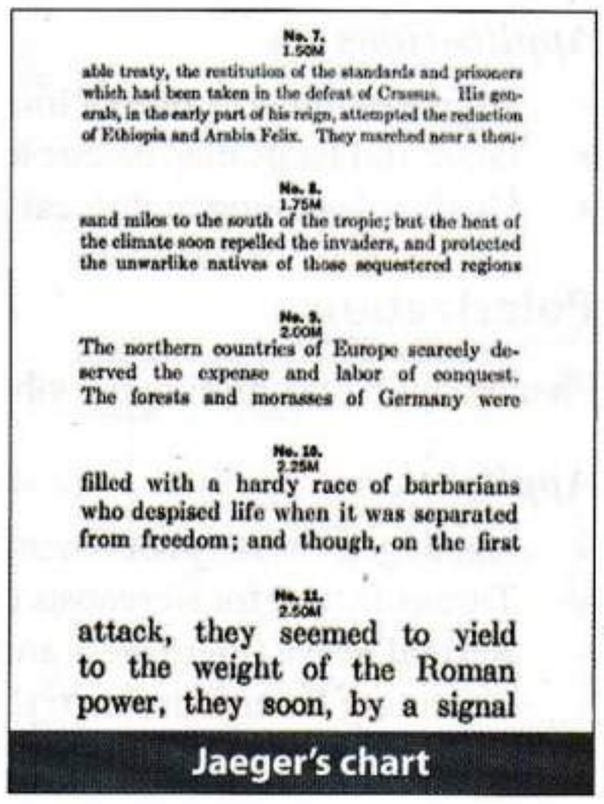
- Electroencephalographic (EEG) recording made from the occipital lobe in response to visual stimuli, (usually as gratings or a flickering checkerboard)

Indirect assessment by observing the various milestones in development

- **Blink reflex** - present since birth
- **Menace reflex** - present around 5 months of age-due to reflex closure of eyes on approach of an object
- **Fixation reflex** - present on Day 1 – central, steady and maintained (CSM) – but well developed by 4–8 weeks

Tests for Near Vision

- Jaeger's chart
- Roman test type
- Snellen's near vision test


No. 7.
1.50M
able treaty, the restitution of the standards and prisoners which had been taken in the defeat of Crœsus. His generals, in the early part of his reign, attempted the reduction of Ethiopia and Arabia Felix. They marched near a thou-
No. 8.
1.75M
sand miles to the south of the tropic; but the heat of the climate soon repelled the invaders, and protected the unwarlike natives of those sequestered regions
No. 9.
2.00M
The northern countries of Europe scarcely deserved the expense and labor of conquest. The forests and morasses of Germany were
No. 10.
2.25M
filled with a hardy race of barbarians who despised life when it was separated from freedom; and though, on the first
No. 11.
2.50M
attack, they seemed to yield to the weight of the Roman power, they soon, by a signal

Jaeger's chart

Tests for Contrast Sensitivity

- Cambridge low-contrast gratings
- Regan chart
- Arden Gratings
- Pelli-Robson chart
- Bailey-love contrast chart
- FACT charts

Mnemonic

CRAP BF

Pelli-Robson chart

Letters are organized as TRIPLETS - with decreasing contrast - done at a distance of 1 meter

OPTICS

Visible wavelengths of electromagnetic radiation between 400 nm and 780 nm are known as Light.

Properties of Light and Its Ophthalmological Application

Interference

Modification in intensity of light in the region of superimposition

Applications

- **Destructive interference** occurs in **corneal stroma** due to the spacing of collagen bundles, which helps to maintain transparency
- Antireflection coating on spectacles
- Optical coherence tomography (OCT)

Diffraction

Flaring out of light in the shadow zone as it passes around an obstacle or through a small aperture.

Applications

- Source of imperfection of image in small pupil (< 2.5 mm)
- Glare and halos may be due to diffraction
- Used in designing multifocal IOLs

Polarization

Phenomenon of confining the vibrations of a wave in a direction perpendicular to wave

Applications

- Haidinger's brush phenomenon in pleoptics
- Titmus fly test for stereopsis uses polarization property
- **Retinal nerve fiber layers** are birefringent and thus, polarization of light may be used to measure **its thickness** – GD_x PRO (Scanning Laser Polarimetry).

Scattering

Re-radiation of incident light in different direction due to irregularities in the path of light.

Applications

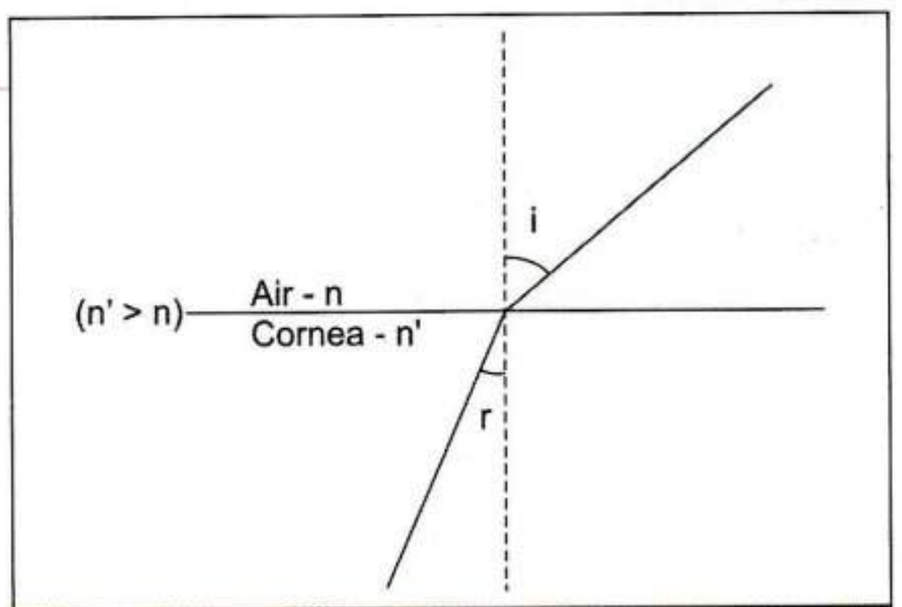
- Red light scatters least and violet most (depends on wavelength) - this property of red light is used in the construction of traffic signals
- Sky appears blue due to scattering
- Flare (proteins in AC), corneal haze in edema
- Glare at night or in bright sunlight

Refraction of Light

It is the phenomenon of change in path of light, when it travels from one medium to another.
Refraction from rarer (air) to denser (cornea) medium is towards normal.
Applications of refraction are used in:

Total Internal Reflection

A ray of light travelling from a denser to rarer medium is reflected back if the incident angle is more than the critical angle. $\angle i > \angle c$
Used in Gonioscopy[Q], Applanation tonometer, fiber optics.

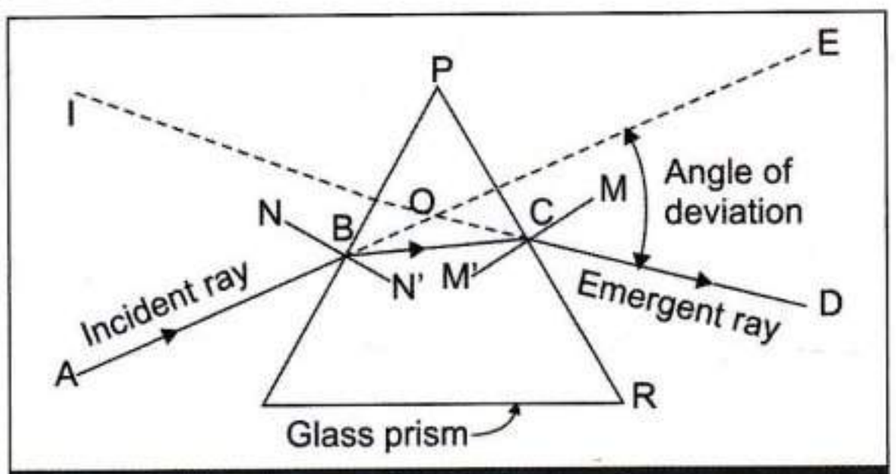


Refraction

Prisms

- Light rays are deviated towards the BASE of prism
- Objects seen through prisms are displaced towards APEX or away from base
- Image formed is erect and virtual

PD (Δ) -1 Prism diopter is the apparent displacement of an object by 1 cm when kept at 100 cm distance/1 m
1 PD = ½ degree deviation.



Refraction of light through prism

Image formed towards apex

Uses

- Diagnostic
  - Measurement of angle of deviation in squint
  - To diagnose microtropia - 4Δ prism test
  - To assess fusional reserve - useful to assess presence of binocular single vision
  - To assess likelihood of diplopia after proposed squint surgery

- Therapeutic
  - For convergence insufficiency - Base out prisms
  - To relieve diplopia in squint

Lenses

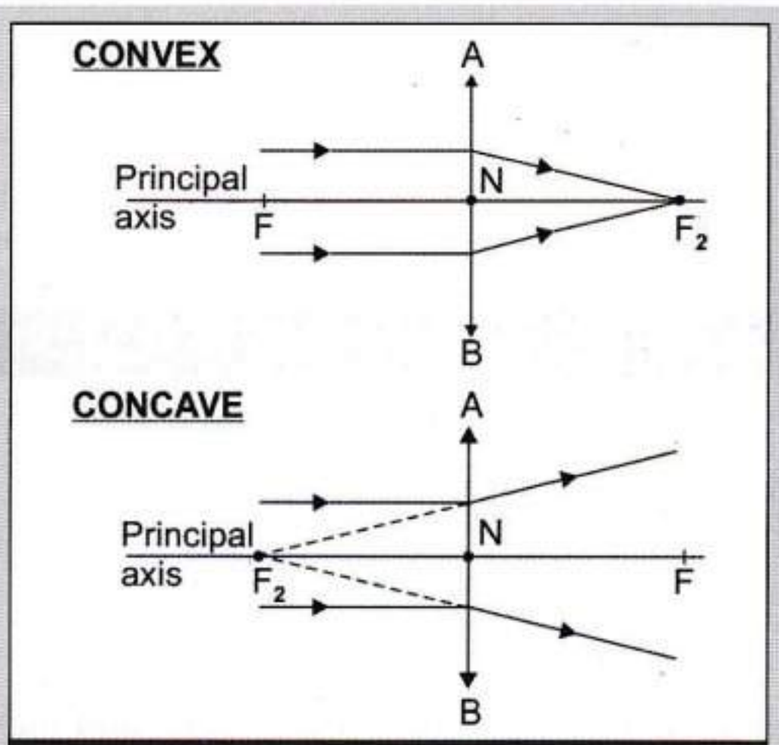
N = Nodal point/principal point: Point where principal plane and principal axis intersect

F_2 = Principal Focus/Focal Point: Point on principal axis where light rays after refraction converge (convex) or appear to diverge (concave)

f = Focal length - distance between N and F_2

$$\text{Power of Lens (D)} = \frac{1}{\text{focal length (f)}}$$

$$\frac{1}{V} + D = \frac{1}{\text{L1 (distance of object)}}$$



Cardinal data of lens

As a rule all points to left on Nodal point are negative and right are positive

Types of Lenses

Spherical Lenses

Convex Lens	Concave Lens

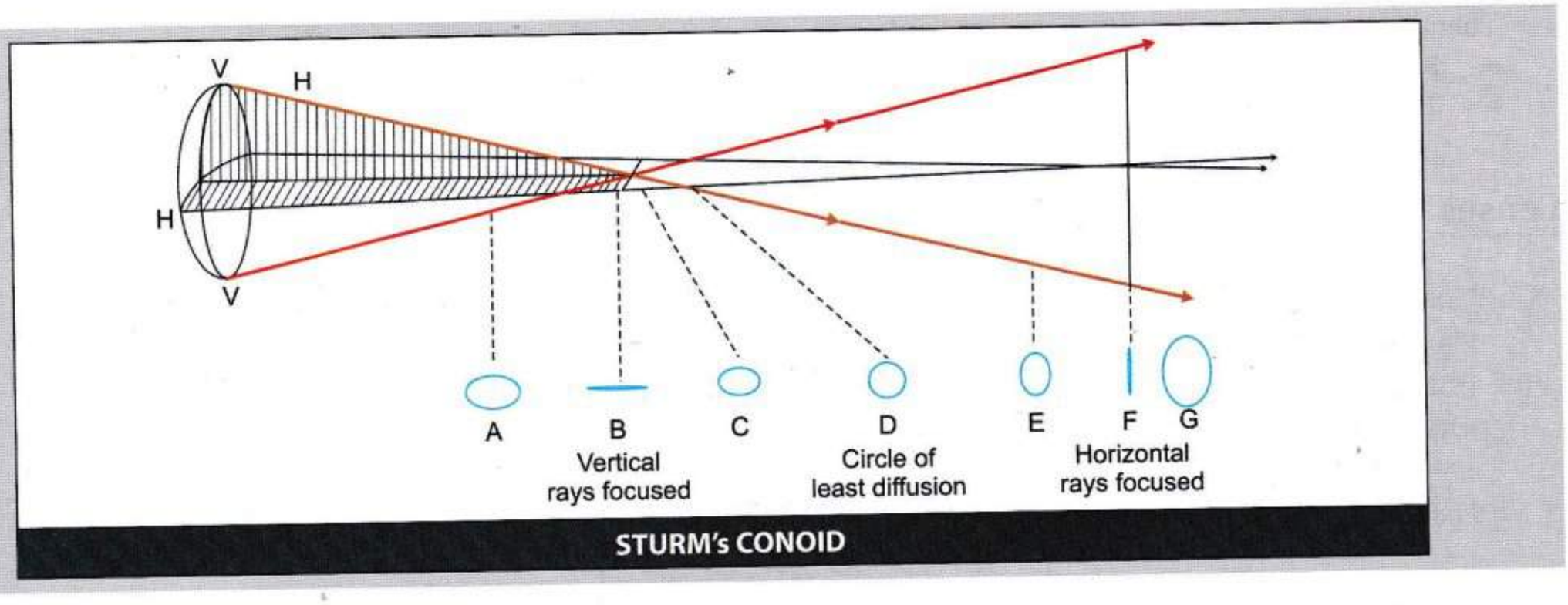
• **Converging** lenses[Q]
• **Plus** lens
• Identification
  ▪ Thick in center
  ▪ Object appears magnified, when seen through it
  ▪ On moving convex lens, **object moves in opposite direction**
• **Uses**[Q]
  ▪ Correction of hypermetropia, aphakia, presbyopia
  ▪ In ophthalmoscopy (+ 20 D in indirect)
• Usually, real and inverted image but may produce an erect and virtual image
	• **Diverging** lenses[Q]
	• **Minus** lens
	• Identification
	  ▪ Thick at periphery
	  ▪ Object appears minified, when seen through it
	  ▪ On moving concave lens, **object moves in same direction**
	• **Uses**[Q]
	  ▪ Correction of myopia
	  ▪ As HRUBY lens (-58.6D) for fundus examination
	• Always a virtual, erect and diminished image

Astigmatic Lenses

Cylindrical Lenses	Toric Lenses[Q]

• Planoconvex or planoconcave (one plane surface and other is part of a cylinder, either convex or concave)
• Power is present in direction at right angle to axis only - image formed is a line for a point object - focal line
• Uses
  ▪ Maddox rod test (squint)
  ▪ Correct astigmatism
	• **Spherocylindrical** (unequally curved in both meridians)
	• Both surfaces have power, the surface with minimum curvature and minimum power is known as base curve
	• Configuration of rays refracted through a toric surface is known as STURM'S conoid
	• **Uses**[Q]
	  ▪ Jackson's cross cylinder test[Q]
	  ▪ Correct high regular astigmatism[Q]

Contd...



STURM's CONOID

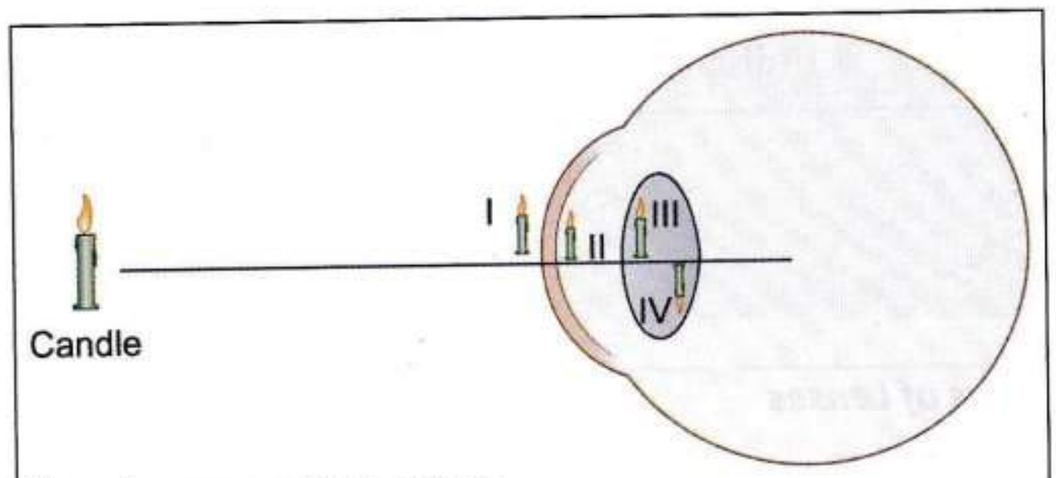
Reflection of Light

Purkinje Images/Catoptric Images

- Each refracting interface in the eye also acts as a spherical mirror, reflecting a small portion of light, and thus forming the catoptric or Purkinje-Sanson images

Uses

- **Keratometry** (measurement of corneal curvature) and **placido disc** (corneal surface regularity measurement) are based on **Ist** Purkinje Image
- For diagnosing status of lens in eye
  - **Aphakia:** [Q]Two Purkinje image seen (I and II)
  - **Pseudophakia:** [Q]Three Purkinje images seen (I, II and IV)
- Hirschberg corneal reflex uses Ist Purkinje image for diagnosis and measurement in squint
- **Pachymeter** (corneal thickness measurement) use image **I and II**



Four Images are formed from
- **Image I:** Anterior corneal surface
- **Image II:** Posterior corneal surface
- **Image-III:** Anterior lens surface
- **Image-IV:**[Q] Posterior Lens surface

Images I, II and III are virtual and erect, whereas Image **IV is real and inverted**[Q].

Purkinje Images

OPTICS OF EYE

The main function of eye as an optical system is to focus light rays on the retina

↓

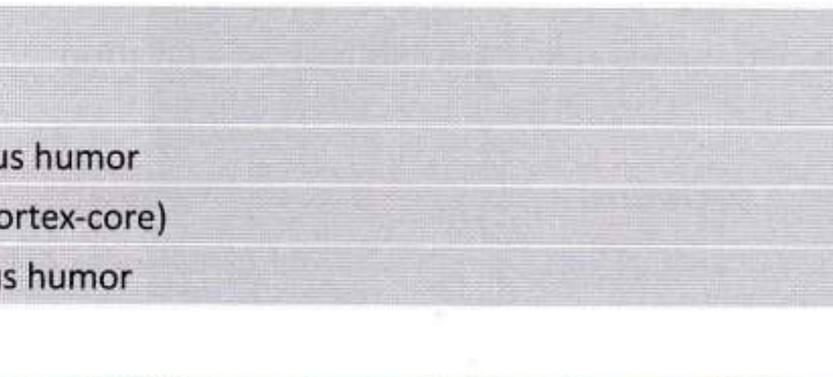
This can be achieved by **converging** the light rays by refracting interfaces of

↙ ↘

	Cornea		Lens	
	Anterior surface	Posterior surface	Anterior surface	Posterior surface
Position of surface behind anterior corneal surface	0 mm	0.5 mm	3.6 mm	7.2 mm
Radii of curvature	7.7 mm	6.8 mm	10 mm	–6.0 mm
Refractive power	+48.83D[Q]	– 5.88D	+19D	
	+43D to +44D			

(Data based on Gullstrand's Schematic Eye)

Optics of the eye were further simplified by **Listing's reduced** eye



The reduced eye (distances in mm behind anterior corneal surface)

Principal point (P)	1.35
Nodal point (N)	7.08
First focal point (F_1)	–15.7
Second focal point (F_2)	24.13

Dioptric power of eye +58.6D[Q] Power of cornea +43 D Power of Lens +16D

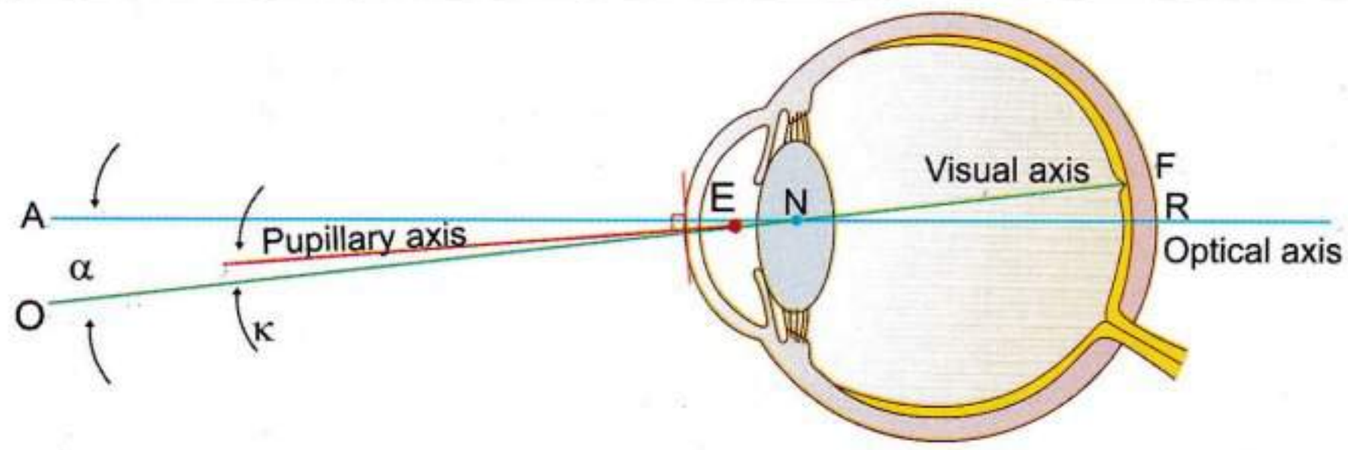
Refractory power depends on[Q]

- Radii of curvature[Q]
- Difference in refractive index between two media at interface of refraction
  Anterior surface of cornea has maximum refractive power due to maximum change (0.376) in refractive index from air to cornea[Q]
- Axial length of eyeball[Q]

Refractive indices of the transparent media of the eye (Gullstrand)[Q]

Air	1.000
Cornea	1.376
Aqueous humor	1.336
Lens (cortex-core)	1.386–1.406
Vitreous humor	1.336

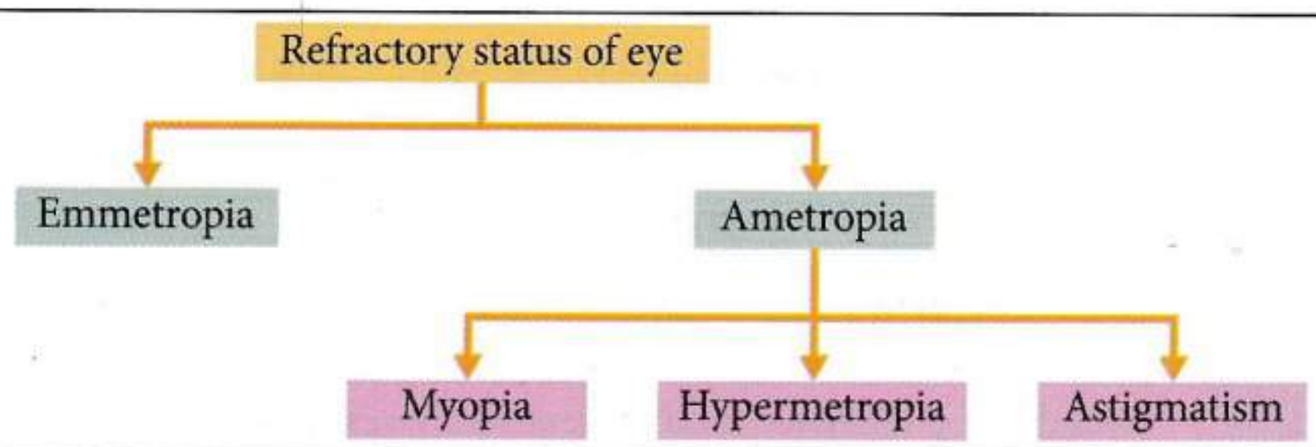
VISUAL AXES AND ANGLES OF EYE



ANR– Anatomical axis/optical axis[Q]
OENF– Visual axis (object to fovea)[Q]
BE– Pupillary axis

Angle Kappa (κ)[Q] **– Formed between visual axis and pupillary axis**
Angle alpha (α)– Formed between visual axis and anatomical/optical axis

REFRACTIVE ERRORS



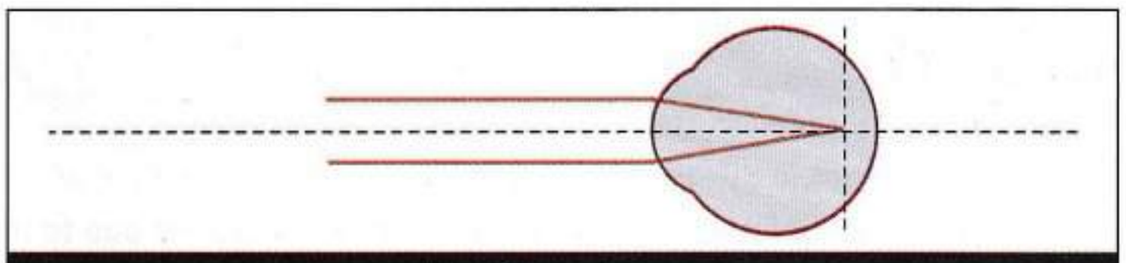
Emmetropization

At birth	By 3 years	3–14 years
Axial length = 18 mm Cornea – more curved = 52 D AC depth – shallow ↓ **Hypermetropia of 2–3 D**[Q]	Axial length = 23 mm Cornea – flattens = 43 D AC – deepens	Axial length increases by 1 mm to attain adult normal value = 24 mm ↓ Around **7 years** of age eye achieves **emmetropization**

Myopia/Short-Sightedness

A refractive error in which parallel rays of light coming from infinity are **focused in front** of the retina, with accommodation being at rest.

In simple words, **myopic eye has more converging power** (>58.6D), thus, light rays come to a focal point before retina.



Myopia

Nearsightedness-light focused in front of the retina

Mechanisms

- **Correlation myopia** - due to abnormal correlation between various parameters which lead to emmetropization
- **Component myopia**

Axial (MC Type)	Curvatural	Positional	Index
Axial length of eye ↓ 1 mm ↑ = 3D myopia[Q]	Curvature of cornea or lens ↓ As curvatures increases, so, radius of curvature decreases 1 mm ↓ = 6D myopia	Position of lens ↓ Moves anteriorly	Refractive index of lens ↓ Increases
Associated with precocious growth in children causing Simple/School Going myopia and **Buphthalmos** (congenital glaucoma)	May be due to **Keratoconus**, Lenticonus or Spherophakia	Due to anterior subluxation of lens (as seen in **Weill-Marchesani** syndrome)	Seen in **Nuclear cataract** due to Sclerosis

Symptoms

- Difficulty/**Diminution of far vision**
- Asthenopia – patient squeezes eyes/brings eyelid closer in order to relax ciliary muscles and see clearly
- **Floaters** – due to associated vitreous synchysis/syneresis
- Metamorphopsia

Signs

1. Pseudoproptosis – large, prominent eyeballs (due to increase in axial length), which appear to be bulging
2. **Optics in Myopia**

Far point comes near[Q]—becomes finite

↓

Thus, patients do not need to accommodate for near vision

↓

Develop **convergence insufficiency**
(Near reflex is a triad of Accommodation, convergence, miosis, thus, in absence of accommodation, no convergence)

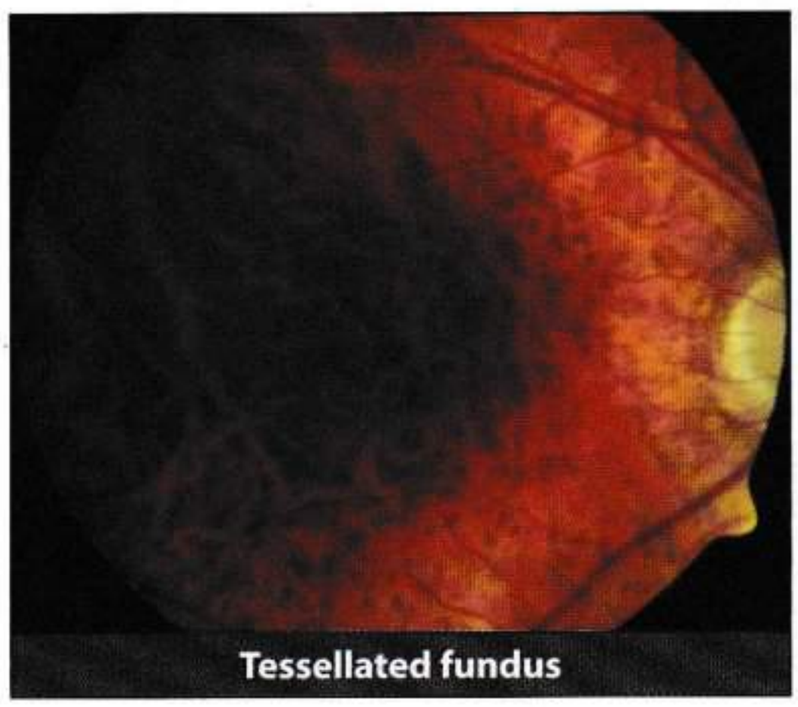
(CAM)

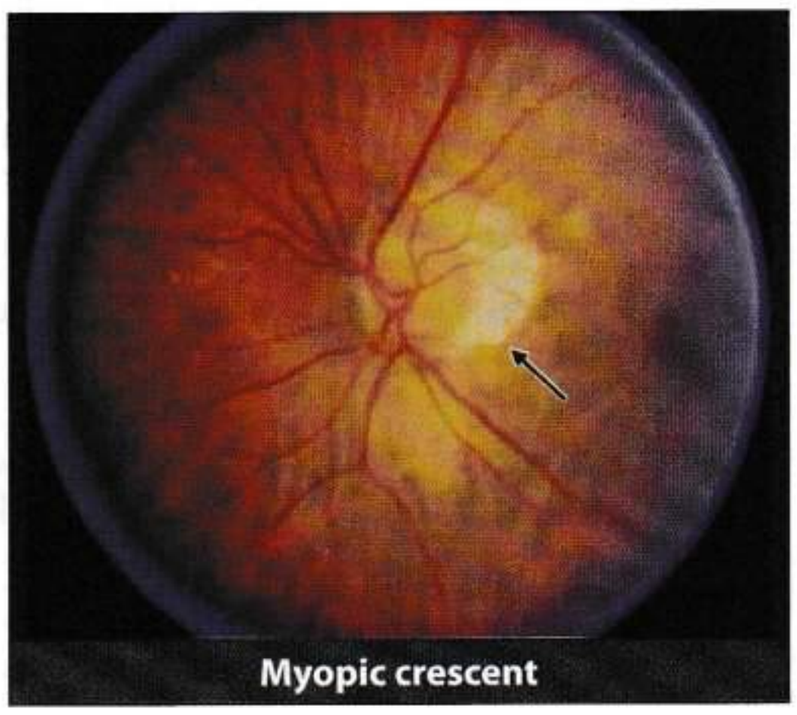
↓

Eyes develop tendency for divergent squint (**exophoria**)

- Angle kappa is negative in High myopia - may lead to **Pseudoesotropia** (apparent convergent squint) - ?
- Nodal point moves farther away from retina - image seen becomes Larger

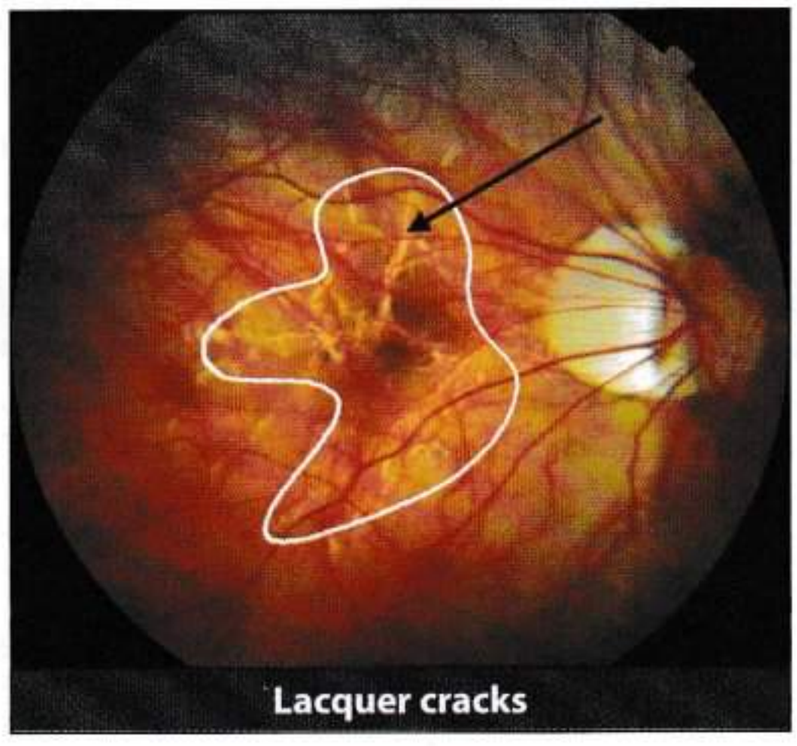
3. Deep anterior chamber
4. Lens - has increased prevalence of nuclear and posterior subcapsular cataract
5.
   - Stiles Crawford effect - cause of decreased vision in high myopia
   - Ocular rigidity is decreased because of increase in ocular volume
   - **Increased incidence of pigmentary glaucoma** and Low tension glaucoma
6. **Fundus Signs** - seen only in cases of **Pathological/Degenerative myopia** (myopia > 6D or axial length of eye > 26 mm)
   - **Temporal myopic crescent** - occurs as a result of disparity in area between sclera (which stretches due to elongation of globe) and RPE-choriocapillaris complex
   - **Tessellated/Tigroid fundus** - diffuse attenuation of RPE leads to visible choroidal vessels


Tessellated fundus


Myopic crescent

- **Supertraction**–Apparent dragging of retinal and choroid tissue nasally over the optic nerve - appearance of tilted optic disc
- **Posterior Staphyloma** (Scarpa's staphyloma)[Q]–Pathognomonic sign - ectatic bulging of the sclera due to focal thinning and degeneration
- **Lacquer cracks**[Q]–Rupture in RPE-Bruch's membrane complex, visible as criss-crossing lines

Posterior staphyloma


Lacquer cracks

- **Foster-fuch spots**[Q]**:** Dark-red circular patch at macula due to subretinal hemorrhage and choroidal neovascularization
- Lattice degeneration of retina
- **T/Y sign** - exposure of central retinal artery and vein for a variable distance posterior to their primary bifurcation
- Vitreous degeneration with posterior vitreous detachment (PVD)

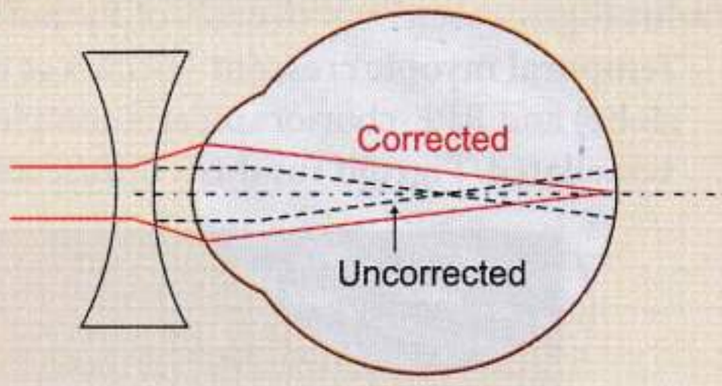
Complications

- Rhegmatogenous retinal detachment - most common complication[Q]
- Vitreous hemorrhage
- Choroidal neovascularization

Treatment

For Low to Moderate Myopia

- **Spectacles** - spherical concave lenses (Minus Power)
  - Diverging light rays with a concave lens to focus on retina
  - Never overcorrect—**Minimum acceptance prescribed**
  - In children, myopic correction must be fully done to enhance development of normal accommodation and convergence reflex



- **Surgical** - Aim to **achieve flattening of central cornea - decrease curvature**
  - **Radial keratotomy**—obsolete
  - **Laser based surgeries - Excimer** (Excited dimer) laser

    Most commonly **Argon Fluoride laser** (ArF)-193 nm[Q] wavelength

    Acts by **photoablation**[Q] of corneal stroma
    - **Photorefractive keratectomy (PRK)** - central 6 mm of anterior stroma ablated to correct -2D to -6D of myopia
    - **Laser assisted in-situ keratomileusis (LASIK)**[Q]

A corneal **flap** (180 microns) is created with a microkeratome, usually nasally hinged

↓

Followed by stromal ablation - 10 microns for very 1D myopia to be corrected or **Munnerlynn** formulae
(Ablation depth = (optical zone)^2 × Diopter/3)

↓

A residual stromal thickness of at least 250 microns is left to prevent ectasia

Contraindications to LASIK

- If age < 18 years
- Corneal thickness < 450 microns (Pachymetry advised preoperatively)
- Glaucoma/Retinal vascular disease/Active ocular disease
- Refraction unstable for at least 12 months

- **C-LASIK:** Custom laser selectively corrects inherent aberrations of each individual eye after assessment by corneal topography or wave front aberrometry

Recent Advances

ReLEx (Refractive Lenticule Extraction) and **SMILE** (Small Incision Lenticule Extraction) technique - uses femtosecond laser to create a small lenticule within corneal stroma **(flapless surgery)** which is removed via an incision < 4 mm compared to 20 mm incision in LASIK.

Patient is raised to the contact glass of the femtosecond laser

↓

Suction ports are activated to keep the patient's eye fixated in the correct position

↓

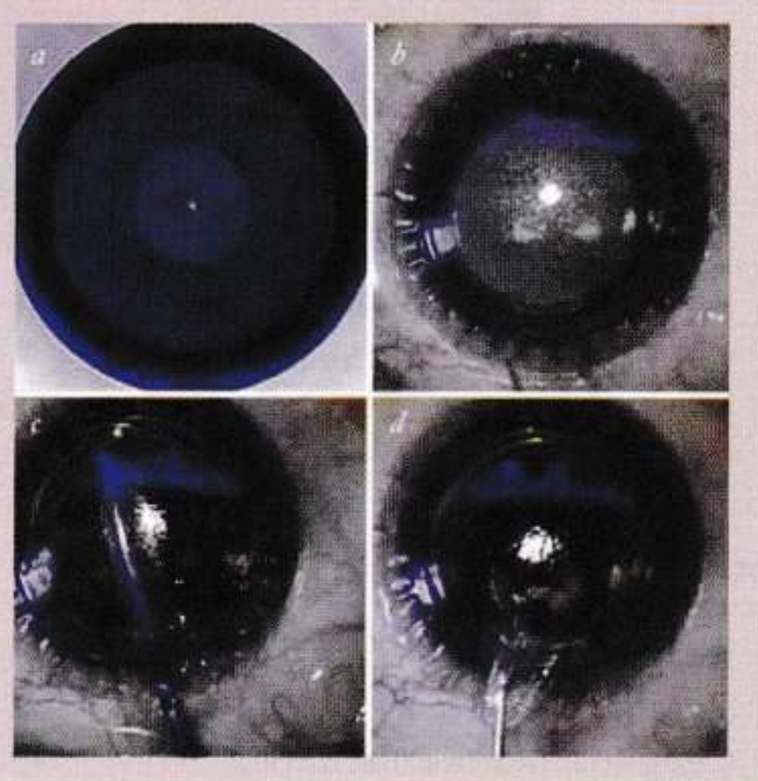
Lenticule is created - The lower interface of the intrastromal lenticule is created first (using an out-to-in direction), followed by the upper interface of the lenticule (using an in-to-out direction), known as the cap

↓

Finally a 2–3 mm tunnel incision is created (usually supero-temporal) that links the cap interface to the corneal surface

↓

Lenticule is separated and extracted



- **Orthokeratology** - nonsurgical reversible method of molding cornea with overnight wear of unique rigid gas-permeable contact lenses to correct myopia from 1D to 3D.
- Intracorneal rings (**INTACS**) - up to 3D myopia correction

For *High Myopia*

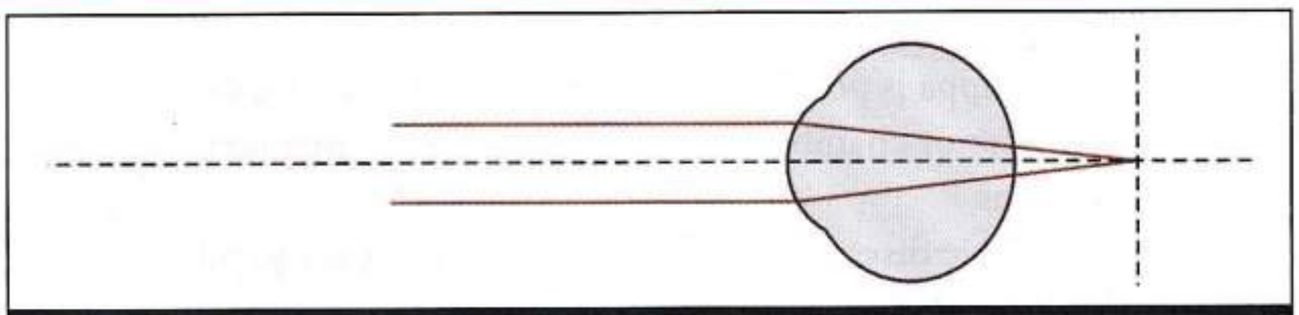
- **Contact lens:** For Myopia ≥10D, contacts are better as they avoid peripheral distortion and minification of image produced by high power spectacles
- Refractive lens exchange with clear lens extraction (**Fucala's operation**)
- Phakic refractive lenses (**PRL**) – IOL of appropriate power implanted in the eye (iris claw lens, angle supported AC lens, PC lens in the sulcus) with the crystalline lens in place.

EXTRA MILE	
Low myopia may be inherited	AD
High myopia may be inherited	XLR/AR ✓
Hypermetropia may be inherited	AD

Hypermetropia/Long Sightedness

A refractive error in which parallel rays of light coming from infinity are **focused behind**[Q] **the retina**, with accommodation being at rest.

In simple words, hypermetropic eye **has less converging power** (< 58.6D), thus light rays come to focus after a longer distance, forming the image behind retina.



Hypermetropia

Farsightedness-light focused behind the retina

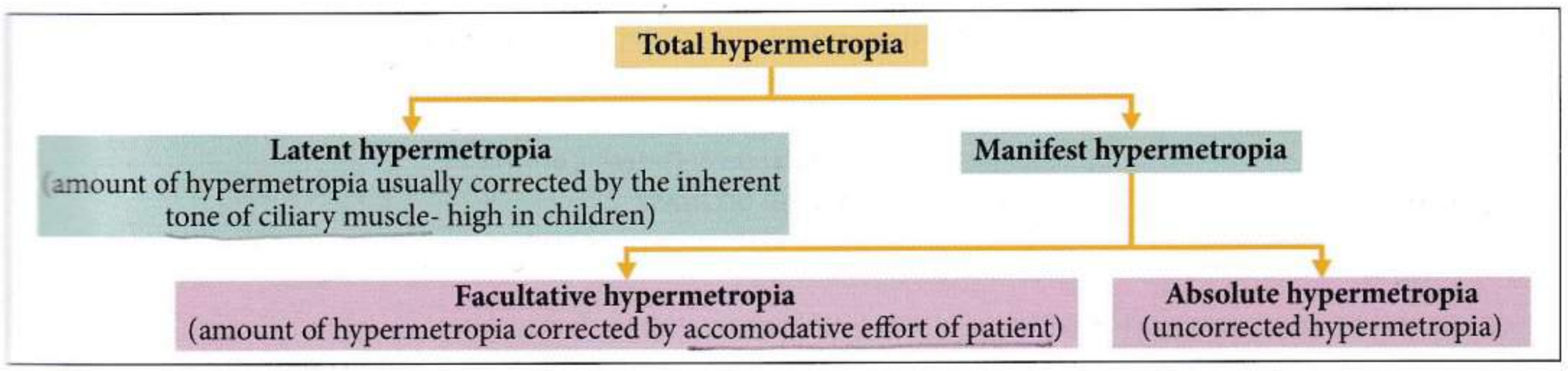
Mechanisms

- **Correlation hypermetropia:** Due to normal biological variations (between various parameters) in the development of eyeball
- **Component Hypermetropia**

Axial	Curvatural	Positional	Index
Axial length of eye ↓ 1 mm = ↓3D	Curvature of cornea or lens ↓ As curvature decreases, radius of curvature increases	Position of lens ↓ Moves posteriorly	Refractive index of lens ↓ decreases
Microphthalmos Intraocular tumor	Cornea plana Microcornea	Posterior dislocation of lens	Cortical cataract Diabetes

- **Functional hypermetropia:** Seen in **Internal Ophthalmoplegia**[Q] - paralysis of sphincter pupillae and ciliary muscle leading to loss of accommodation and thus causing loss of near vision.

Types of Hypermetropia


Total hypermetropia
Latent hypermetropia
(amount of hypermetropia usually corrected by the inherent tone of ciliary muscle- high in children)
Manifest hypermetropia
Facultative hypermetropia
(amount of hypermetropia corrected by accomodative effort of patient)
Absolute hypermetropia
(uncorrected hypermetropia)

Symptoms

- **Asthenopia:** Patient complaints of tiredness of eyes, watering, mild frontal headache which occurs due to sustained accommodative effort for maintaining clear near vision in hypermetropia
- **Loss of near vision**[Q]

Signs

- Size of the eyeball is normal or small
- **Optics in hypermetropia**

Far point is virtual

↓

Thus eyes accommodate excessively

↓

Develop **Esophoria/Esotropia** (Accommodative convergent squint) (due to over accommodation, over convergence, i.e. inward movement of eyes takes place, leading to Esodeviation)

  - Near point becomes Distant-moves farther
  - Angle kappa is positive-may lead to **Pseudoexotropia**
- Shallow Anterior chamber: predisposes patient to **primary angle closure Glaucoma**[Q]
- **Fundus signs**
  - Small optic disc with ill-defined margins-**Pseudopapillitis**[Q]
  - Shot silk appearance of retina
- Recurring stye, chalazion, blepharitis may develop due to repeated excessive rubbing of eyes, done to relieve asthenopia
- Pseudo-fleischer's ring may be seen.

Treatment

- **Spectacles** - Spherical convex lenses (Plus Power)[Q]
  - Converging lenses - to focus light rays at the retina
  - Prescribed after determining total Hypermetropia through refraction under cycloplegia (to abolish accommodation and tone of ciliary muscle)
- **Surgical** - Aim to achieve central steepening of cornea
  - Thermal laser keratoplasty - using thallium-holmium-chromium (THC: YAG) laser to correct 0.75D to 2.5D of hypermetropia
  - Hyperopic LASIK
  - Conductive Keratoplasty (CK): Uses radiofrequency energy (Non-laser) to shrink corneal tissue, reshaping and steepening cornea

To summarize the spherical refractive errors,

In myopia: All parameters **Increase** (Power of eye, Axial length, curvature, index, etc)

↓

Thus for treatment-**MINUS lenses** or flattening of cornea

In Hypermetropia: All parameters **DECREASE**

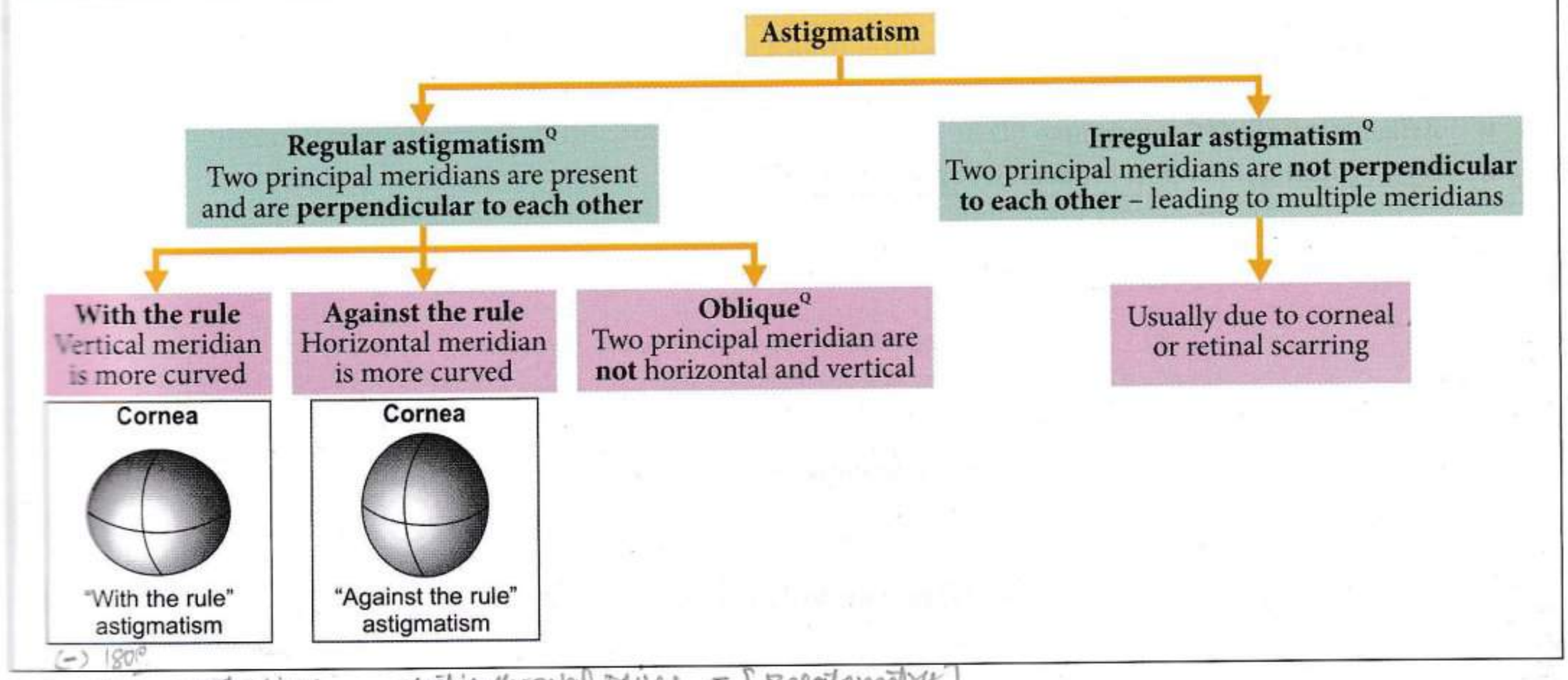
↓

Thus for treatment - **PLUS lenses** or steepening of cornea

Astigmatism

Refractive error in which the refraction varies in different meridians of eye, due to which light rays fail to converge in a point focus.

Classification


Astigmatism
Regular astigmatism[Q]
Two principal meridians are present and are perpendicular to each other
Irregular astigmatism[Q]
Two principal meridians are not perpendicular to each other – leading to multiple meridians
With the rule
Vertical meridian is more curved
Against the rule
Horizontal meridian is more curved
Oblique[Q]
Two principal meridian are not horizontal and vertical
Usually due to corneal or retinal scarring
Cornea
"With the rule" astigmatism
Cornea
"Against the rule" astigmatism

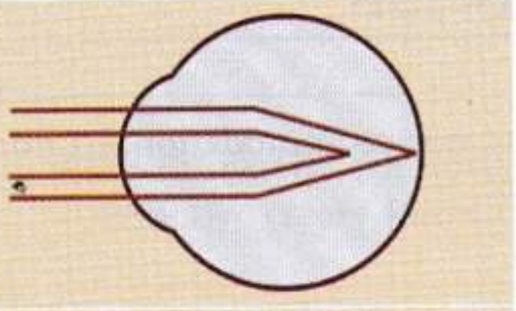
(-) 180°

Horizontally oval Mires Vertically oval Mires – [Keratometry]

Refractive Types of Regular Astigmatism

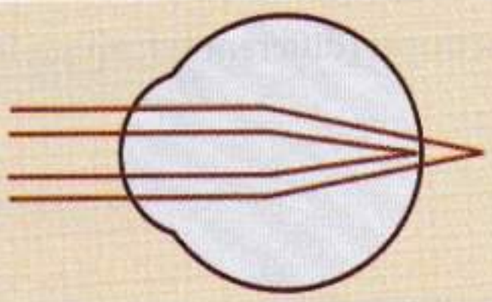
Simple Myopic

One meridian focused on retina
Other focused in front of retina (myopic)



Simple Hypermetropic

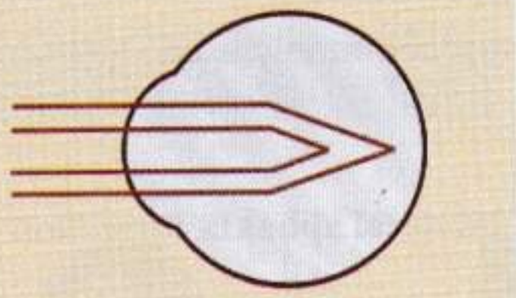
One meridian focused on retina other focused behind retina (hypermetropic)



Compound Myopic

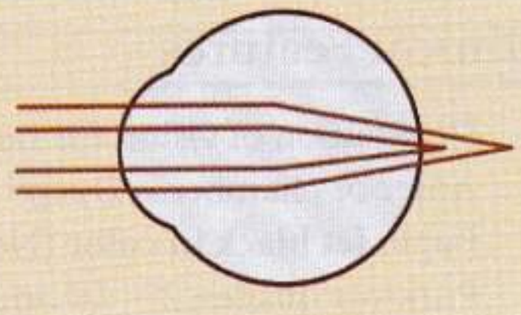
Both meridians are focused in front of retina (Myopic) but at different points

Most common type[Q]



Compound Hypermetropic

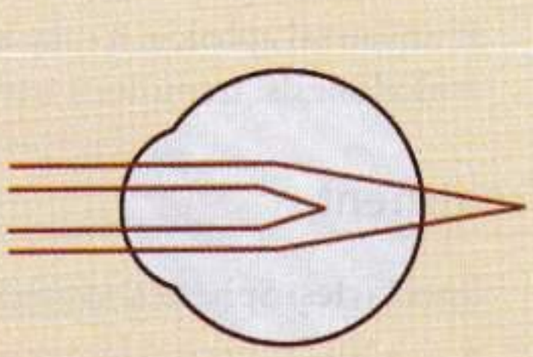
Both meridians are focused behind the retina (Hypermetropic) but at different points



Mixed

One meridian focused in front of retina (myopic)
Other focused behind (Hypermetropic)

Least visually troublesome[Q]



Symptoms

- Blurring of vision - on reading, letters are seen to be "running together"
- Asthenopia/eye strain
- Tilting of head

Treatment

- **Spectacles-Cylindrical/toric lenses:** Convex or concave, depending on the refractive type of astigmatism
  - 'With the rule' astigmatism[Q] concave cylinder at 180° or convex cylinder at 90° .
  - 'Against the rule' astigmatism convex cylinder at 180° or concave cylinder at 90°.

Mnemonic

With CV, Against VC

With	con**C**ave [–]	con**V**ex [+]
Against	con**V**ex [+]	con**C**ave [–]

- Toric contact lens: soft[Q] or hard-soft (Hybrid)[Q] or gas permeable
- **Surgical**
  - Astigmatic keratotomy: Flattening of the steep meridian by making transverse or arcuate cuts, 5-7 mm away from pupil, perpendicular to it. Corrects astigmatism from 4 to 6D
  - Limbal relaxing incision (**LRI**): Correct astigmatism from 1 to 2D
  - Astigmatic LASIK: Corrects upto 5D
  - **Ruiz procedure:** For post keratoplasty astigmatism

Aphakia

Absence of crystalline lens from the eye: Aphakia

↓

Converging **power of the eye decreases**

↓

Light rays come to a **focus behind retina**

↓

High degree of **Hypermetropia and Astigmatism** seen

Clinical Features

- Diminution of vision **for far and near** (due to absence of lens, no accommodation, so, no near reflex)[Q]
- Anterior chamber is **Deep**[Q]
- Pupil: **Jet black in color** (Normal pupil is black)
- Purkinje images: 2[Q] - III and IV are absent
- If unilateral aphakia, it may lead to amblyopia due to high anisometropia (different refraction from both eyes)
- Iridodonesis: tremulous iris[Q]

Treatment

- **Spectacles:** Spherical convex lenses (plus power) to correct hypermetropia
  - +10D spherical lenses with cylindrical component are most commonly used
  - **Disadvantages of high power spectacles**
    - **Magnification**-2% for every 1D power

If **unilateral aphakia** correction → Produces **Diplopia** due to image size difference between two eyes

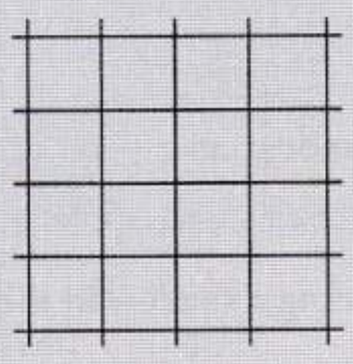
If **bilateral aphakia** correction → Problem due to Hand-eye co-ordination, as **larger objects appear nearer**

    - **Pin Cushion distortion** - a spherical aberration due to thick spectacles
    - **Jack in the Box phenomenon[Q]/Roving Ring scotoma** - a prismatic aberration
    - Cosmetically, the eyes look enlarged (Frog eyes) behind the thick spectacles
- Contact lens: Give advantage of around 10% magnification only
- IOL implantation (Intraocular lens)[Q]: **Treatment of choice**

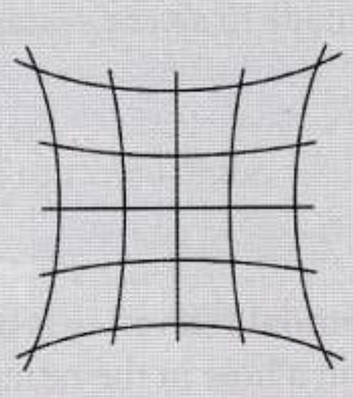
Miscellaneous

Aniseikonia

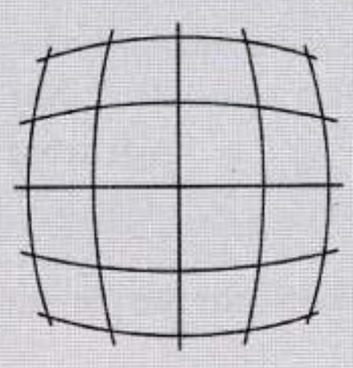
- Distortion of vision with **changes in shape and/or size** of image[Q]



Object



Pincushion distortion
seen with
high plus correction



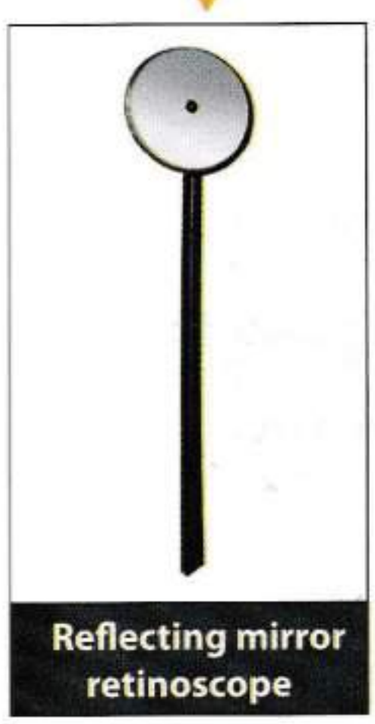
Barrel distortion
seen with high
minus correction

Anisometropia

- The state in which there is **unequal refractory power in both eyes**
  - Usually well-tolerated up to a difference of 2.5 D or 5% image size between both eyes (as 1D = 2% change in image size)
  - Difference of more than 5% image size in both eyes result in Diplopia
  - **Surgical treatment** is usually preferred for correction

REFRACTION

Procedure of determining and correcting refractive errors known as **refraction**

- **Objective refraction**
  - **Retinoscopy**[Q]
    - Manual
      - 
        Reflecting mirror retinoscope
      -
        Priestley-Smith's retinoscope
    - Automated refractometers (uses Scheiner disc principle)
      -
        Self-illuminated Streak retinoscope
- **Subjective refraction**
  - **Adjustment of refraction**
    - Trial and error method
    - Fogging technique
  - **Refinement of refraction**
    - Cylinder
      - Jackson's cross-cylinder test[Q]
      - Astigmatic fan test
    - Sphere
      - Duochrome test
      - Pinhole testing
  - **Binocular balancing**
    - Duochrome test with fogging
    - Prism dissociation method

Retinoscopy/Skiascopy[Q]/Shadow Test[Q]

Method

Patient is made to sit at a distance of **1 m**

↓

Instructed to look at a far point/object to relax accommodation

↓

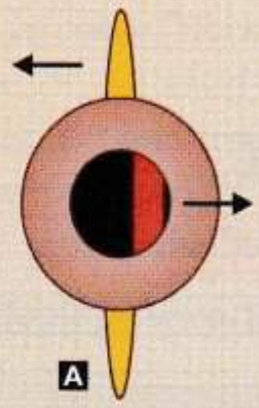
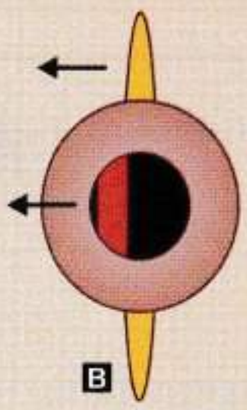
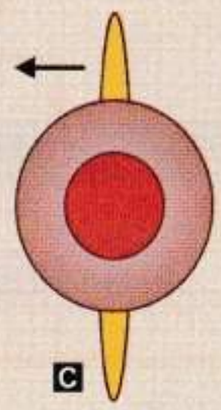
Light is thrown into the patient's eye and **fundal red reflex is observed** casting a shadow in the pupillary area (with a hole in the retinoscope)

↓

Retinoscope is moved in both vertical and horizontal directions

↓

Movement of red reflex is observed

Movement of red reflex **against** the movement of retinoscope	**No movement** of red reflex	Movement of red reflex **with** the movement of retinoscope
↓	↓	↓
>1D Myopia[Q]	1D Myopia[Q]	<1D Myopia[Q] Emmetropia Hypermetropia
 A Against motion	 B With motion	 C Neutral

Similar movement in both meridians (vertical and horizontal) indicates **spherical refractive error**

↓

Neutralization
By addition of Convex (+) or Concave (–) lenses, if spherical error

If cylindrical error (Astigmatism) is present, find the cylinder power with a Spherocylinder lens combination

EXTRA MILE

- In streak retinoscopy, at neutralization the streak (band shaped reflex) disappears if only spherical error is present
- STRADDLING - Method of confirmation of cylinder axis

How to Calculate Refractive Error from Retinoscopic Findings?

Refractive error = Retinoscopic findings in both meridians – Deduction in dioptres (D) for distance (d) – Tonus Deduction (in dioptres) allowance for cyclopleglic drug (Atropine-1D, Cyclopentolate-0.75D, Homatropine-0.5 D)

90°
180°

$$D = \frac{1}{d}$$

e.g. 1 On performing retinoscopy, at **1 m** distance, using **atropine** for cycloplegia, following retinoscopic findings are seen. Calculate refractive error?

+2
+2 → Both axis have equal retinoscopy values, means only a spherical error is present

- Deducting for distance $D = \frac{1}{d} \rightarrow D = \frac{1}{1\ m} = 1$
- Deducting for Tonus allowance of Atropine = 1

+2-1-1
+2-1-1 → 0
0 → Thus, no refractive error
↓
EMMETROPIA

---

e.g. 2 +5
+3 → Both axis have unequal retinoscopy values means astigmatism (cylinder) is present

Deducting as above

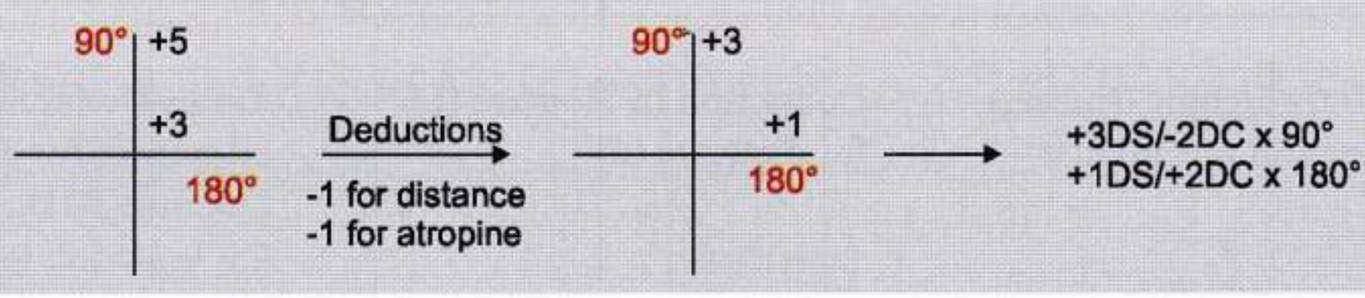
+5-1-1
+3-1-1 → +3
+1 → Choose any one axis as a sphere, second axis becomes astigmatic – cylindrical

How to prescribe spectacles

Power of sphere (DS)/Power of cylinder (DC) **(calculated as C-S)** at axis perpendicular to its power

- **P1:** 90° +3 (s)
  +1 (c)
  180°
  +3DS/(1–3) DC × 90° → +3DS/–2DC × 90°
- **P2:** 90° +3 (c)
  +1 (s)
  180°
  → +1 DS/(3-1) DC x 180° → +1DS/+2DC x 180°

To Summarize



How to Diagnose Refractive Error from Spectacle Prescription

Remember 4 points

- (–) power means correction for myopia
- (+) power means correction for Hypermetropia
- (S) power means correction for spherical error (myopia/Hypermetropia)
- (C) power means correction for cylindrical error (Astigmatism)

e.g.

– 2DS	Minus spherical error	Myopia
+ 2DS	Plus spherical error	Hypermetropia
– 2DC	Minus cylindrical error	Simple myopic astigmatism
– 2DS/–1DC	Minus spherical and cylindrical error	Compound myopic astigmatism
+ 2DC	Plus cylindrical error	Simple hypermetropic astigmatism
+ 2DS/+3DC	Plus spherical and cylindrical error	Compound hypermetropic astigmatism
+ 2DS/–3DC	• Minus and plus both errors • Cylindrical power greater than spherical power	Mixed astigmatism
–1.75DS/+1.25DC	• Minus spherical and plus cylindrical error • **Cylindrical power < Spherical power** (Thus it cannot be Mixed astigmatism) ↓ In Such cases we have to use the method of **Simple Transposition** of a Prescription **New Sphere** = Add power of sphere and cylinder **New Cylinder** = Same power but opposite sign (– to + and + to –) **New Axis** = Rotate the axis of cylinder by 90° ↓ **–1.75 + (+1.25) DS/–1.25 DC** ↓ **–0.50 DS/–1.25 DC**	Compound Myopic astigmatism
–1.25DC at 180°	Minus cylindrical error with axis at 180°	Simple Myopic astigmatism (With the rule)
–2.75DS/+4DC at 180°	Minus spherical and plus cylindrical error with axis at 180 Cylindrical power > spherical power	Mixed Astigmatism (Against the rule)

Subjective Tests

Fogging Method

Done **to overcome abnormally active accommodation**

Plus lenses are placed in front of each eye in excess of expected retinoscopy findings

↓

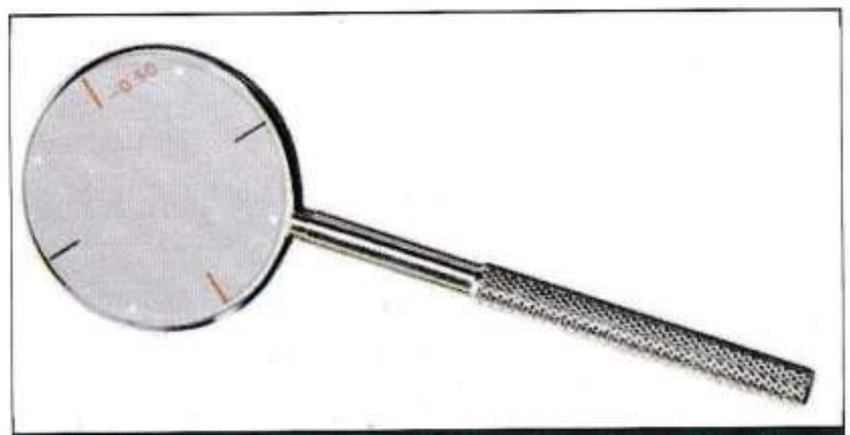
Increases power of eye, makes the patient Myopic or short sighted

↓

In this case excessive accommodative power is relaxed as patient is already short sighted

Jackson's Cross-Cylinder Test

- For subjective refinement of Cylinder
- Uses a TORIC lens-**'Spherocylindrical'**
  (spherical component is half of the power of cylinder, with opposite sign and with axes at right angles)
- Most common used as **–0.5D sphere with +1.0D cylinder**
- It creates an affect of two cylinders –0.5DC and +0.5DC, placed at right angles



Jackson-cross cylinder test

Handle at axis of 45° with both axes

Duochrome Test

- For subjective refinement of sphere (useful till 6/9 VA)

Patient is asked to read letters on red and green background

Letters on both background equally sharp	Letters on **red** background are more **clear**	Letters on **green** background are more **clear**
Emmetropia	**Myopia**	**Hypermetropia**

Duochrome test chart

Pin Hole Test

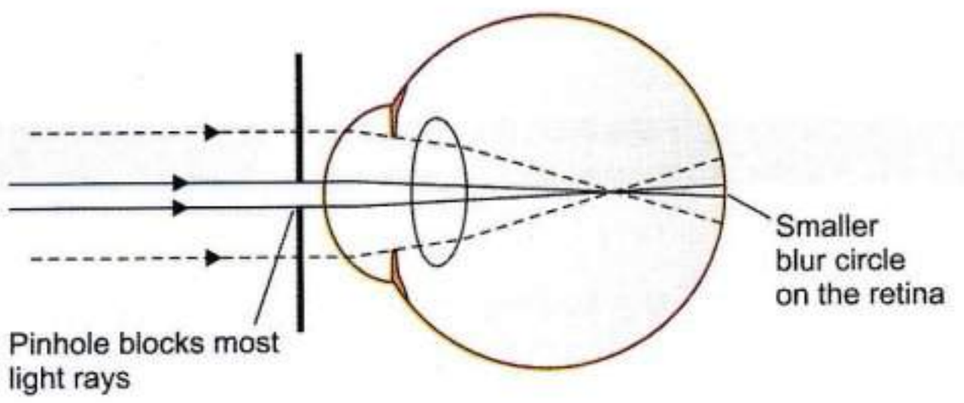
- Improvement in VA while looking through a pin hole indicates incorrect refractive correction by retinoscopy.

Dimunition of vision on Snellen's chart

Pinhole placed infront of one eye and Snellen's VA recorded

VA **improves**	VA does not improve	**Decrease**
Refractive error	Ocular pathology	**Macular pathology**

As the pinhole allows only one ray of light from each point of object to pass through, thus producing a smaller retinal blur leading to improvement in VA



Pinhole

- Size of pinhole is **1 mm**
- It is used to neutralize refractive errors **till 4D**

(Source: Elkington Optics, 4th edition)

ACCOMMODATION

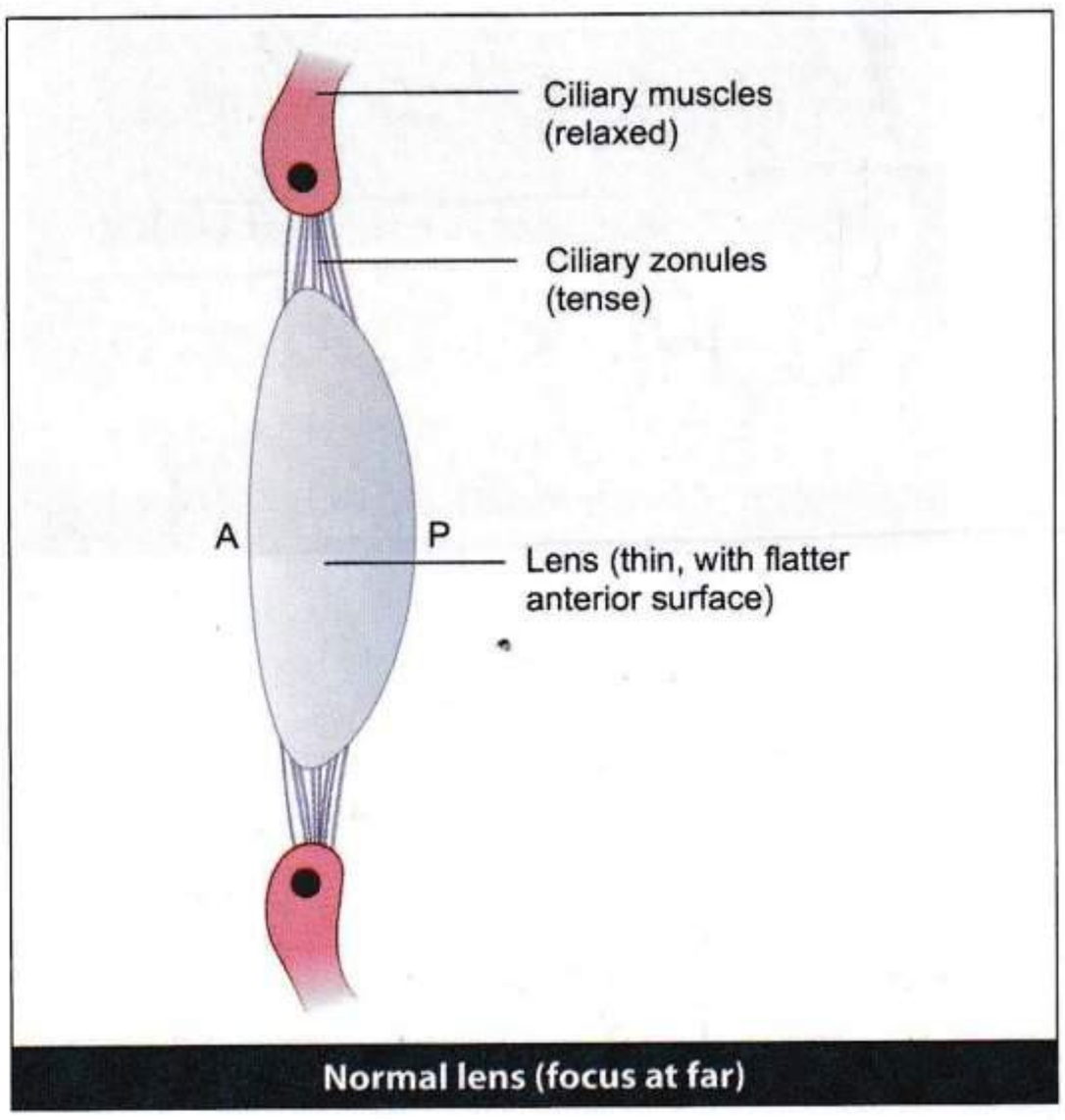
For a distant object, parallel light rays fall on cornea and lens which are converged on to retina

↓

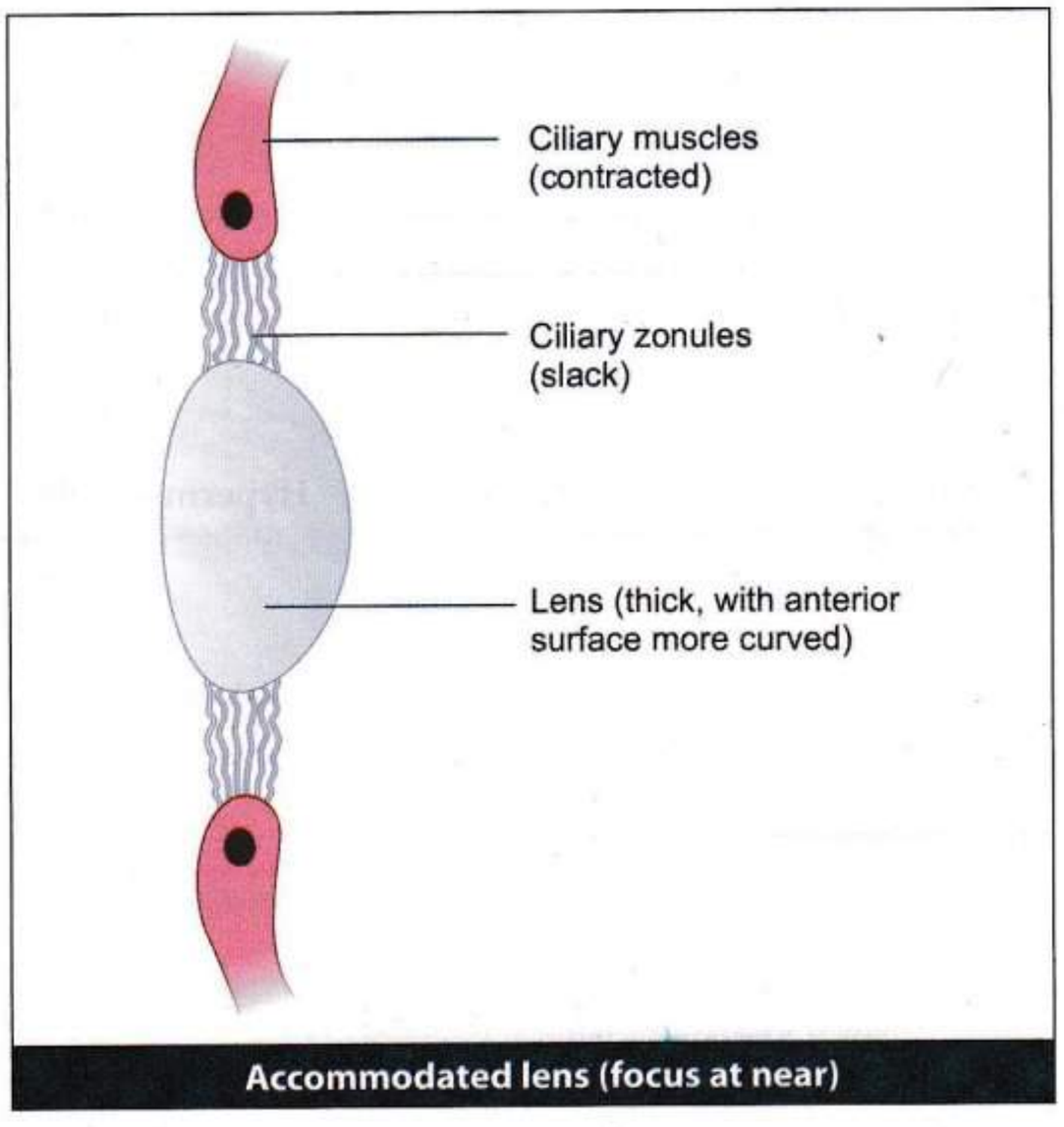
But for a Near object (at about 30 cm), diverging light rays fall on cornea and lens, thus, **excessive convergence power is needed to focus a near object on to the retina**

↓

This **phenomenon of increase in converging power of eye to focus on a near object** is achieved by augmenting the power of lens through increase in its anterior curvature from the action of ciliary muscle



Normal lens (focus at far)



Accommodated lens (focus at near)

Changes in Eye with Accommodation

Ciliary muscle[Q]	Contracts
Ciliary ring diameter	Decreases
Ciliary zonules[Q]	Relax (Tension decreased)
Anterior curvature of lens[Q]	Increases
Posterior curvature of lens	No change
Axial diameter of lens (thickness)	Increases
Equatorial diameter of lens	Decreases
Lens dioptric power	Increases

EXTRA MILE

- Amplitude of accommodation (A) is the change in refractive power of eye produced by accommodation
  A = P – R
  P – {refractive power of fully accommodated eye = 1/near point (meters)}
  R – {refractive power of eye at rest = 1/far point (meters)}
- Average time for far to near accommodation – 0.64 sec.
- Average time for near to far accommodation – 0.56 sec.

Anomalies of Accommodation

Presbyopia	Cycloplegia	Spasm of Accommodation
Physiological insufficiency of accommodation	Pharmacological **paralysis** of accommodation	Involuntary, sustained excessive accommodation
Due to receding near point in **old age (~ 40 years)**	Drug induced (atropine, homatropine, cyclopentolate) or due to Internal ophthalmoplegia	Drug induced (miotics - echothiophate, DFP) or in children due to uncorrected hypermetropia
Loss of **near vision**	Blurring of near vision with photophobia	**Pseudomyopia**[Q]
• **ADD for near**—with convex spherical spectacles (single vision, **bifocal**[Q], multifocal) A rough estimate for the presbyopic add for various age levels is as follows: 45 years: + 1.00 to + 1.25 D 50 years: + 1.50 to + 1.75 D[Q] 55 years: + 2.00 to + 2.25 D 60 years: + 2.50 to + 3.00 D *The difference between distance corrections and strength needed for near vision is called ADD* • **Monovision**—Making one eye myopic by surgical procedure to enable clear near vision	Self recovery	Treat with cycloplegics like atropine

EXTRA MILE

Near Reflex—comprises of 3 components

- Accommodation—as discussed above
- Miosis—constriction of pupil
- Convergence—a disjugate movement, where both eyes move inward

Total convergence = Voluntary + Reflex (Tonic + Fusional + Accommodative + Proximal)

Tonic	Fusional	Accommodative	Proximal
Due to inherent tone of extraocular muscles	To ensure similar retinal images fall on corresponding retinal areas	Occurs along with stimulus for accommodation	Induced by nearness of an object

- **AC/A ratio**–the relationship between accommodative convergence (AC) and accommodation (A). Normally **AC is 3 prism diopters for 1D of accommodation**
- In Hypermetropes—excessive accommodation is needed to focus on a near object, thus AC/A ratio is decreased
- In myopes—AC required is more than the accommodative effort, (as patient is short sighted), thus AC/A ratio is increased

AMBLYOPIA (LAZY EYE)

Unilateral or bilateral, **partial loss of vision without any organic cause** in the cornea, lens, retina or visual pathway.

Type

Strabismic	Anisometropic	Ametropic	Stimulus deprivation
Due to unilateral suppression in a large angle squint	Due to a difference in refractive error between 2 eyes—usually > 2.5D	Due to **uncorrected bilateral** high refractive error - More common in hypermetropia	Due to vision deprivation caused by cataract, corneal opacities, ptosis, etc.
MC type of amblyopia Best prognosis		If due to astigmatism–meridonial amblyopia	Worst prognosis

Clinical Features

- Decreased visual acuity: **A two line difference in best corrected visual acuity** (between both eyes or from age specific norm) on Snellen's chart
- **Crowding phenomenon**: Due to abnormal contour interaction, objects seen singly are clearer than in a row or line
- Abnormal contrast sensitivity
- Strabismic amblyopia is not degraded by Neutral Density filters[Q]

Treatment

Amblyopia usually develops within the first 6–7 years of life. Thus, treatment is usually advocated as early as possible.

- **Occlusion therapy[Q]:** Normal eye is occluded using a cotton pad or pirate patch, to allow the amblyopic eye to preferentially fixate. Usually time occlusion is done with conventional occlusion

> Occlusion of normal eye for X days (X = Age of child), followed by occlusion of amblyopic eye for 1 day.

So, for a 4 year old, occlusion is done for a total 5 days in 4:1 (normal eye to amblyopic eye) cycles.

- **Penalization**—vision in normal eye is blurred using Atropine.[Q]
- CAM vision stimulator – used to stimulate the amblyopic eye
- **Pleoptics**—to establish foveal fixation—obsolete—done in patients suffering from Eccentric Fixation (EF)
- Levodopa-Carbiodopa—by facilitating neurotransmission at dopaminergic synapses in retina and cortex.

AMAUROSIS

Amaurosis is the term used for **complete loss of vision** in one or both eyes in the absence of ophthalmoscopic or other objective signs.

Bilateral Amaurosis

- Seen in **acute nephritis** with pregnancy or chronic renal disease
- **Uremic amaurosis** – due to circulation of toxic material acting upon the higher visual centres, both **pupil are dilated and react to light** (as lower centres are not affected) with **complete loss of vision**.

Amaurosis Fugax

Transient (seconds to minutes) monocular blindness caused by a temporary lack of flow of blood to retina, optic nerve or the brain, presenting as a curtain that descends (falls down) or ascends.

Causes are as follows

Embolic	Ocular
• **Carotid bifurcation thromboembolism – most common cause** • Great vessel or distal internal carotid artery atheroembolism • Cardiac emboli (valve, mural thrombi, intracardiac tumor) • Drug abuse – related intravascular emboli	• Anterior ischemic optic neuropathy (AION) • Central or branch **retinal artery occlusion** (often embolic)[Q] • Central retinal vein occlusion[Q] • Nonvascular causes (hemorrhage, pressure, tumor, congenital)
Hemodynamic	**Neurologic**
• Extensive atheromatous occlusive disease • Inflammatory arteritis (Takayasu's disease/Giant cell arteritis) • Hypoperfusion (cardiac failure; acute hypovolemia; systemic diseases disturbing blood viscosity, coagulability, or content)	• Brainstem, vestibular, and oculomotor lesion • Optic neuritis[Q], optic nerve or chiasm compression • **Papilledema**[Q] • Multiple sclerosis • Migraine/Retinal migraine • Psychogenic
Idiopathic	

LAST MINUTE REVISION – ONE LINERS

- Minimum angle of resolution is 30–60 seconds of arc.
- Snellen's chart measures Minimum Resolvable visual acuity.
- On Snellen's chart, each letter subtends an angle of 5 minutes from their respective distance at the nodal point of eye.
- Pelli-robson chart is used to measure the Contrast sensitivity.
- Gonioscopy is based on the principle of Total internal reflection.
- Objects seen through prism are displaced towards the Apex of the prism.
- There are 4 Purkinje images, 4th is inverted.
- Total power of eye is 58.6 D, Power of cornea is 43-44D, power of lens is 16-19D.
- Maximum refractive power is in the Anterior surface of cornea.
- Maximum refractive index is in the centre (Nucleus) of lens.
- Angle kappa is formed between the visual axis and the pupillary axis of the eye, usually 5 degrees.
- Angle kappa is negative in myopia – Pseudoesotropia and positive in hypermetropia – Pseudoexotropia.
- A child at birth is Hypermetropic (+ 2 to + 3D).
- Foster fuch spots, Lacquer cracks, Supertraction, Posterior staphyloma are features of Pathological/degenerative myopia (Myopia >6D).
- Most common complication of myopia is Rhegmatogenous retinal detachment.
- Spherical concave (diverging) lenses are used for treatment of myopia and Spherical convex (converging) lenses are used for the treatment of hypermetropia.
- LASIK – Argon fluoride (EXCIMER) laser is used – 193 nanometer wavelength, Photoablation.
- ReLEx and SMILE are the latest surgeries for myopia using Femtosecond laser.
- Regular astigmatism is if the principal meridian are perpendicular to each other.
- Irregular astigmatism if the principal meridian are not perpendicular to each other.
- Deep anterior chamber, jet black pupil, hypermetropia, Jack in the box phenomenon, Pin cushion defect – seen in Aphakia.
- Aniseikonia – change in shape or size of image.
- Retinoscopy/shadow test/ skiascopy, Refractometry are objective tests for refraction.
- Jackson' cross cylinder test and astigmatic fan test are used for refinement of cylindrical error.
- Duochrome test and pinhole test are used for refinement of spherical error.
- Movement of red reflex against the retinoscope indicates >1D myopia, when retinoscopy done at the usual distance of 1 meter.
- Size of a pinhole is 1 mm and it is used to neutralixe refractive errors till 4D.
- Presbyopia occurs due to physiological insufficiency of accommodation and is treated with use of convex lenses over the existing myopia correction – Add for near.
- Spasm of accommodation leads to Pseudomyopia, also by strong Miotics.
- During accommodation the ciliary muscle contracts leading to decrease of the ciliary ring diameter with relaxation of the ciary zonules leading to reduced tension, causinf increase in the anterior curvature of lens – change in shape of lens.
- Amblyopia is loss of vision without any associated organic cause.
- Occlusion therapy is done to prevent amblyopia.
- Amaurosis is the term used for complete loss of vision in one or both eyes in the absence of ophthalmological signs.

BONUS PAGE 1

MYDRIATICS AND CYCLOPLEGICS

Salient Features of Common Cycloplegic and Mydriatic Drugs

S.No.	Name of the drug	Age of the patient when indicated	Dosage of instillation	Peak effect	Time of performing retinoscopy	Duration of action	Period of post-cycloplegic test	Tonus allowance
1.	**Atropine sulphate (1% ointment)**	<5 years[Q]	TDS × 3 day	2–3 days	4th day	10–20 days	After 3 weeks of retinoscopy	1D[Q]
2.	**Homatropine hydrobromide (2% drops)**	5–8 years	One drop every 10 minutes for six times	60–90 minutes	After 90 minutes of instillation of first drop	48–72 hours	After 3 days of retinoscopy	0.5D[Q]
3.	**Cyclopentolate hydrochloride (1% drops)**	8–20 years	One drop every 15 minutes for three times	80–90 minutes	After 90 minutes of instillation of first drop	6–18 hours	After 3 days of retinoscopy	0.75D[Q]
4.	**Tropicamide (0.5%, 1% drops)**	**Not used as cycloplegic** for retinoscopy; used **only as mydriatic**)	One drop every 15 minutes for three to four times	20–40 minutes	—	4–6 hours	—	—
5.	**Phenylephrine (5%, 10%)**	Used only as mydriatic	One drop every 15 minutes	30–40 minutes	—	4–6 hours	—	—

Frequent Causes of Decreased Vision[Q]

Causes of gradual, painless and progressive diminution of vision

Age less than 40 years
- Refractive error*
- Keratoconus*
- Corneal dystrophy*
- Developmental cataract
- Juvenile glaucoma
- Retinitis pigmentosa*
- Compressive optic neuropathy
- Hereditary macular degeneration*

**Usually bilateral but can be asymmetrical*

Age more than 40 years
- Presbyopia*
- Age-related cataract*
- Chronic simple glaucoma (primary open-angle glaucoma*)
- Dry age-related macular degeneration (ARMD)
- Diabetic retinopathy*
- Corneal dystrophies*
- Retinitis pigmentosa*
- Drug-induced maculopathy or optic neuropathy*

Sudden and painless causes of diminution of vision

Unilateral
- Retinal detachment
- Retinal vascular occlusion
- Vitreous hemorrhage
- Retinal hemorrhage
- Exudative age-related macular degeneration (ARMD)
- Subluxation or dislocation of the lens

Bilateral
- Bilateral occipital infarction
- Atypical optic neuritis
- Grade IV hypertensive retinopathy with macular star
- Toxic optic neuropathy
- Posterior uveitis[Q]

Diminution of vision associated with pain and/or an acute red eye

Uveitis[Q]
Corneal ulcer[Q]
Acute angle-closure glaucoma[Q]
Endophthalmitis[Q]
Retrobulbar neuritis

IMAGE-BASED QUESTIONS

There are multiple probable questions that can be asked on a single image.

Question number 1 is based on Image 1.

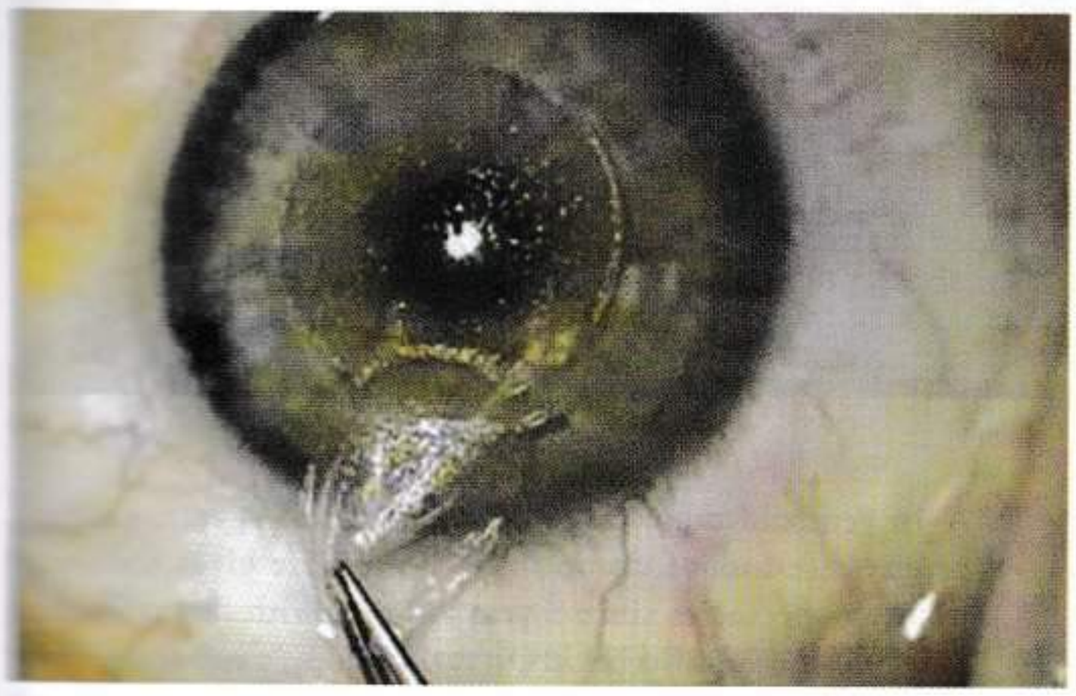


Image 1

1. Identify the ocular surgery being done in the image:
   a. Lasik
   b. Keratoplasty
   c. SMILE
   d. FLACS

Question number 2 is based on Image 2.

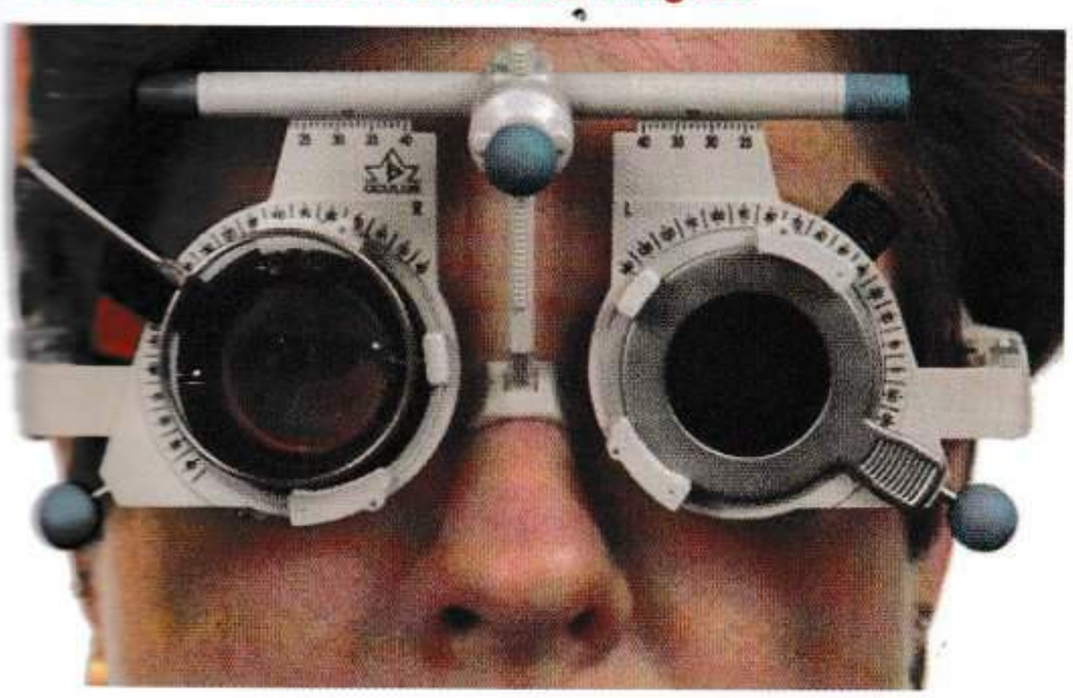


Image 2

2. The optical procedure being done is used for:
   a. Objective refraction
   b. Subjective adjustment of cylinder
   c. Binocular balancing of vision
   d. Subjective refinement of cylinder

Question number 3 is based on Image 3.

Image 3

3. Infant in the image is most likely suffering from:
   a. Accomodative esotropia
   b. Essential infantile esotropia
   c. Bilateral blue dot cataract
   d. Internuclear ophthalmoplegia

Question number 4 is based on Image 4.

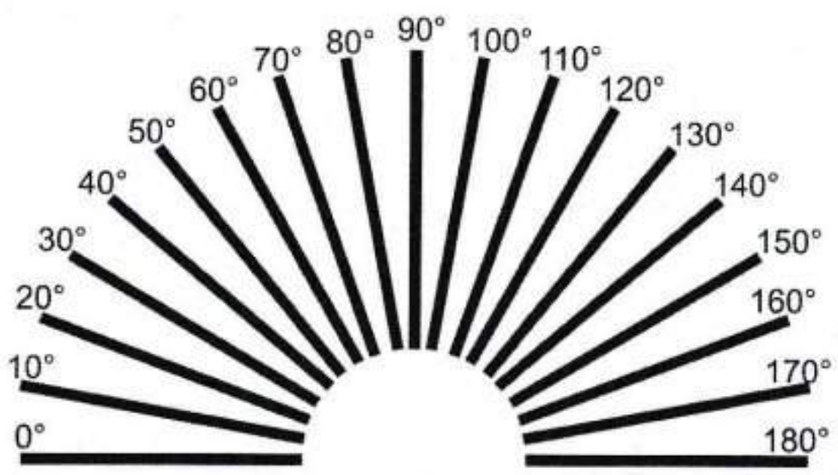


Image 4

4. Instrument shown in the image is used for:
   a. Adjustment of refraction
   b. Refinement of cylindrical correction
   c. Refinement of spherical correction
   d. Binocular balancing

Most Recent Image-based Questions of 2019-2017 are given at the end

Question numbers 5 to 7 are based on Image 5.

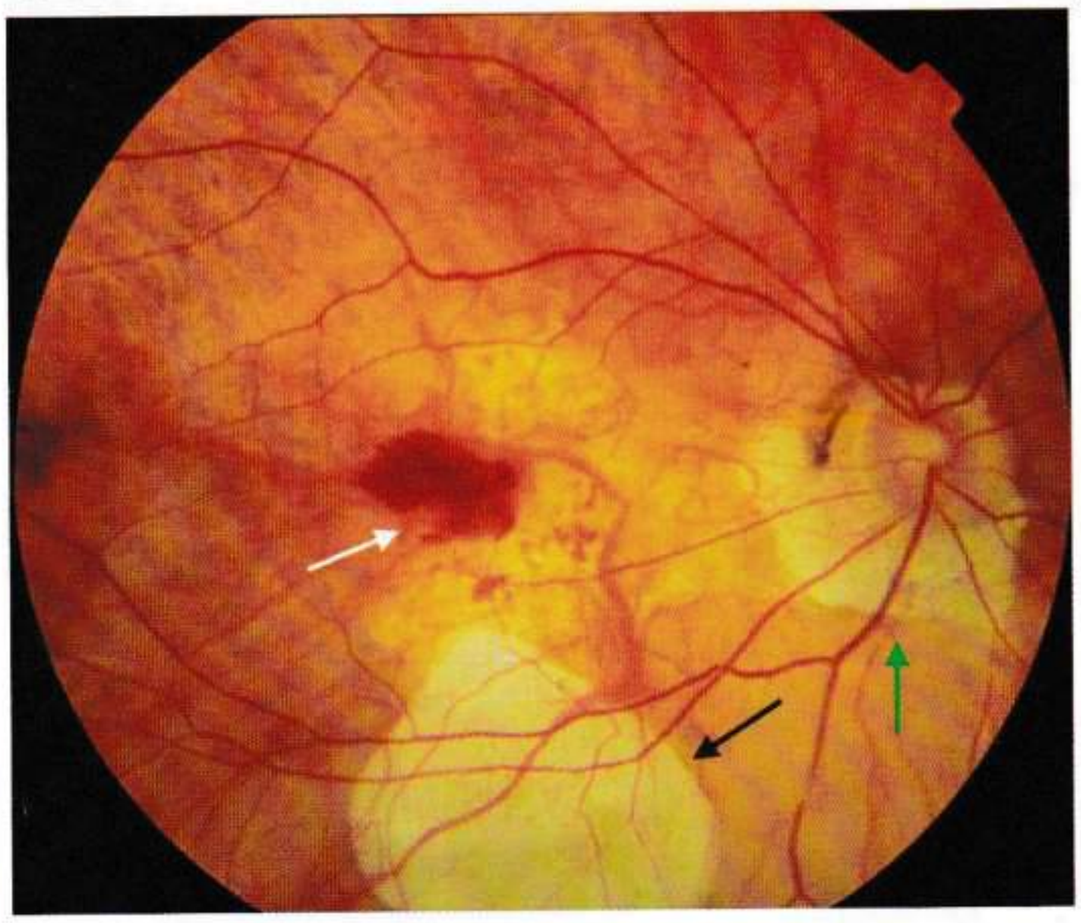


Image 5

5. **All of the following can be seen in the above image, except:**
   a. Foster Fuchs spots
   b. Chorioretinal atrophy
   c. Lacquer cracks
   d. Peripapillary atrophy
6. **The following complications can be seen in a patient with the above fundus image, except:**
   a. Rhegmatogenous retinal detachment
   b. Primary angle closure glaucoma
   c. Vitreous hemorrhage
   d. Foveal Retinoschisis
7. **All of the following are true about the patient with the above fundus image (PGI style):**
   a. The patient has a myopia of 7D
   b. The axial length is 23 mm
   c. Concave Contact lens are superior to spectacles for myopia correction in the patient
   d. It can be associated with Marfan syndrome
   e. It has a prevalence of about 10%

Question number 8 is based on Image 6.

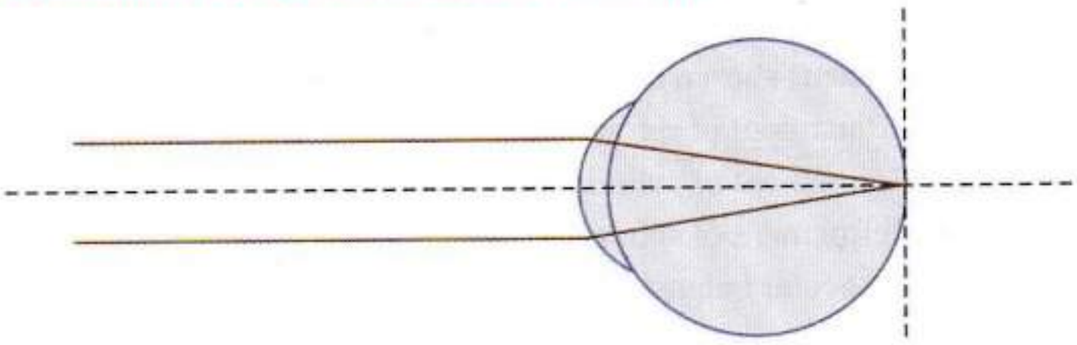


Image 6

8. **Diagnose the refractive condition of the given eye.**
   a. Simple myopic astigmatism
   b. Hypermetropia
   c. Emmetropia
   d. Mixed astigmatism

Question number 9 is based on Image 7.

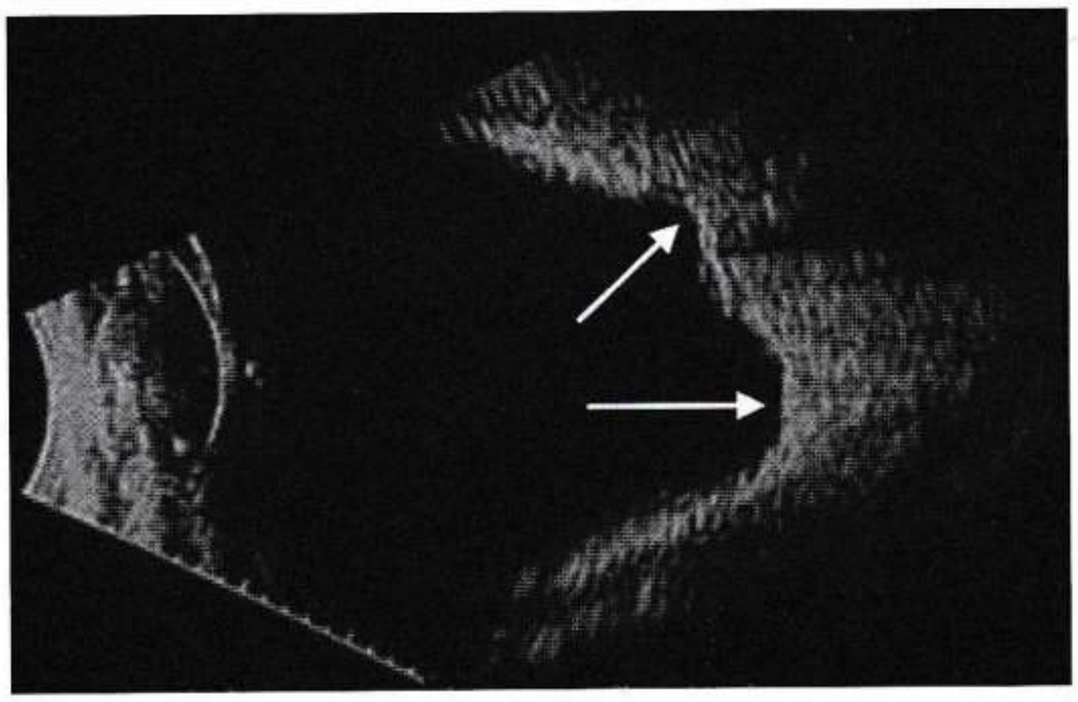


Image 7

9. **A 16 year old male come complaining of severe, gradual, progressive loss of vision in both eyes. He gives history of wearing spectacles since 5 years of age, with last refraction being done 6 months back. On retinoscopy, a refractive error of -8D spherical error is seen. On B scan, the above result was obtained. What can be seen in the B-scan image?**
   a. Posterior staphyloma
   b. Chorioretinal atrophy
   c. Vitreous hemorrhage
   d. Rhegmatogenous retinal detachment

Question numbers 10 and 11 are based on Image 8.

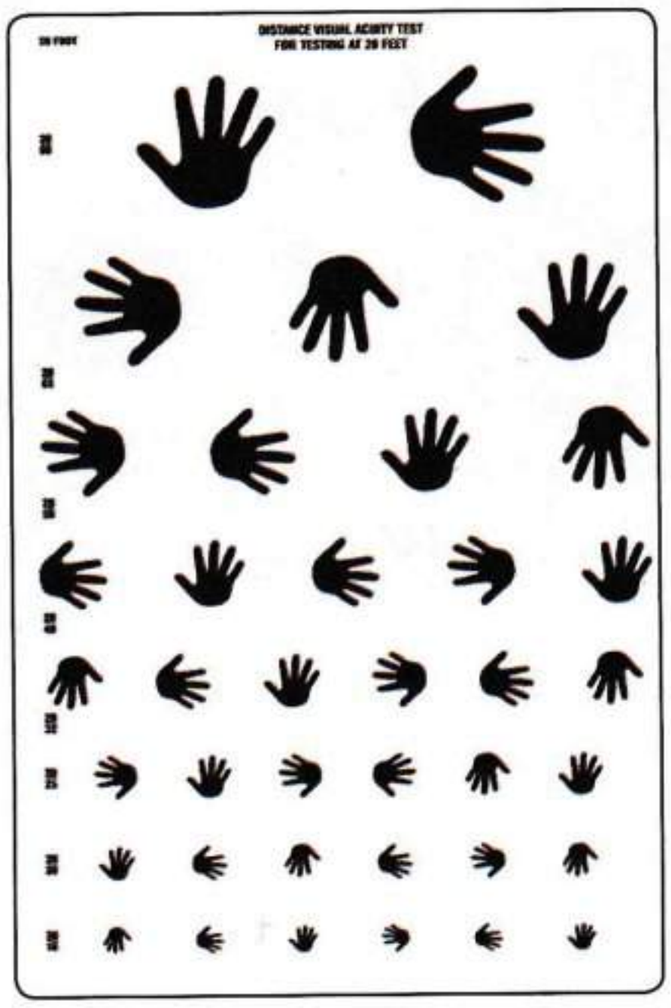


Image 8

10. **The optical instrument seen in the image is used for**
    a. Testing contrast sensitivity
    b. Testing visual acuity in infants
    c. Subjective refinement of refraction
    d. Testing visual acuity in pre-school children

Most Recent Image-based Questions of 2019-2017 are given at the end

11. **Identify the optical instrument shown in the image.**
    a. Landolt's C ring chart
    b. Keeler log MAR crowded test
    c. Sjögren's hand figure test
    d. Allen pre-school hand picture test

Question number 12 is based on Image 9.

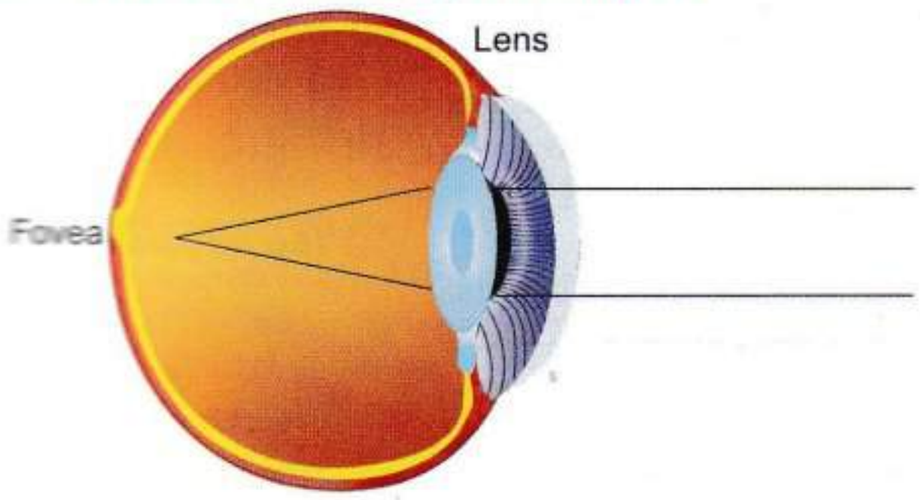


Image 9

12. **Optics of a 15 years old patient shown below, what is the diagnosis based on the optics:** *(AIIMS Nov 2017)*
    a. Astigmatism
    b. Aphakia
    c. Hypermetropia
    d. Myopia

Question number 13 is based on Image 10.

Image 10

13. **Above is a common instrument used in ophthalmology. In order to view the entire retina what is the power of lens you would like to attach to the instrument:** *(AIIMS Nov. 2016)*
    a. +90 D
    b. +78 D
    c. –58 D
    d. +20 D

Question number 14 is based on Image 11.

Image 11

14. **Identify the investigation being done.**
    a. Direct ophthalmoscopy
    b. Cover test
    c. Retinoscopy
    d. Snellen's chart

Most Recent Image-Based Questions of 2019-2017

Question number 15 is based on Image 12.

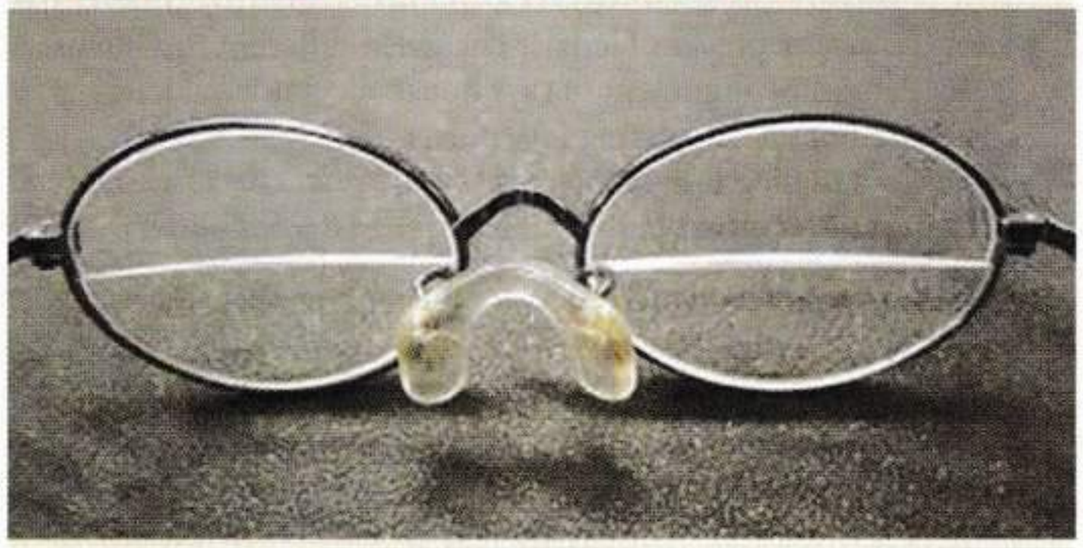


Image 12

15. **Spectacle shown above is used in** *(AIIMS Nov 2018)*
    a. Bifocal for presbyopia
    b. Bifocal for adult aphakia
    c. Bifocal for pediatric aphakia
    d. Progressive bifocal for presbyopia

Most Recent Image-based Questions of 2019-2017 are given at the end

MULTIPLE CHOICE QUESTIONS

Visual Acuity – Tests

16. Distance of patient while reading Snellen chart is *(Recent pattern Nov/Dec 2016)*

a. 6 feet
b. 25 cms
c. 6 meters
d. 25 feet

17. What is the angle subtended by the largest letter on Snellen's chart when viewed from a distance of 6 meters (in minutes)? *(AIIMS Nov 2018, May 2016)*

a. 5
b. 1
c. 50
d. 60

18. Type of visual acuity used in Snellen chart testing *(Recent pattern Nov/Dec 2016)*

a. Minimum visible
b. Minimum resolvable
c. Minimum discriminable
d. Minimum hyperacuity

Optics

19. Which of the following describes image seen through a prism? *(Recent pattern 2014)*

a. Inverted
b. Tilted
c. Near the apex
d. Near the base

20. Focal length of 0.25 m power of lens is– *(Recent pattern 2015)*

a. 40 D
b. 1/4 D
c. 4 D
d. 25 D

21. What is the power of a lens if the focal length is 0.75 m? *(Recent pattern Nov/Dec 2016)*

a. 1.3 D
b. 2.3 D
c. 3.3 D
d. 4.3 D

22. What is sturm's conoid? *(Recent pattern 2015)*

a. Distance between two focal points created by differential refractive power of lens or cornea in different meridians.
b. Pattern of alignment of rays due to a cylindrical lens
c. Method of calculating IOL power
d. Tool in diagnosis of myopia

23. Centre of biconvex lens is called– *(Recent pattern 2015)*

a. Focal point
b. Optical center
c. Epicentre
d. Focal distance

Refractive System of Eye

24. Normal eye power is– *(Recent pattern 2014)*

a. + 6 D
b. + 43 D
c. + 60 D
d. + 17 D

25. Maximum contribution to the refractive power of the eye is by: *(Nov AIIMS 2016)*

a. Anterior surface of cornea
b. Anterior surface of lens
c. Posterior surface of cornea
d. Posterior surface of lens

26. Most important factor determining convergence of light rays on the retina is : *(Recent pattern 2014)*

a. Length of the eyeball
b. Refractive power of the lens
c. Curvature of the cornea
d. Physical state of the vitreous

27. Which component of the eye has maximum refractive index? *(AIIMS 2010)*

a. Anterior surface of lens
b. Posterior surface of lens
c. Centre of lens
d. Cornea

28. Alpha angle is the angle between:

a. Pupillary axis and optical axis
b. Visual axis and optical axis
c. Centre of eyeball rotation and line of fixation
d. None of the above

29. Visual axis is: *(Recent pattern 2015-16)*

a. Centre of cornea to retina
b. Object to fovea
c. Centre of lens to cornea
d. None

30. Normal axial length of the eye– *(Recent pattern 2015)*

a. 18 mm
b. 20 mm
c. 24 mm
d. 28 mm

31. Newborn eye with respect to refractive error is– *(Recent pattern Nov/Dec 2016)*

a. Emmetropic
b. Hypermetropic
c. Myopic
d. Astigmatic

Refractive Errors

32. The most common cause of myopia is: *(DPG 2010)*

a. Increase in length of the eyeball
b. Increase in thickness of the lens
c. Increase in viscosity of aqueous humor
d. Increase in viscosity of vitreous humor

33. Foster fuch's spots are seen in– *(Recent pattern Dec 2012)*

a. Hypermetropia
b. Myopia
c. Astigmatism
d. None

34. Which is the most common complication of pathological myopia? *(DPG 2010)*

a. Glaucoma
b. Cataract
c. Haemorrhage
d. Retinal detachment

35. Which of the following is used for treatment of Myopia– *(JIPMER 2004)*

a. Nd: YAG Laser
b. Excimer Laser
c. Argon laser
d. Holmium laser

36. In senile nuclear cataract what type of myopia is seen– *(Recent pattern Nov/Dec 2016)*

a. Curvature myopia
b. Index myopia
c. Axial myopia
d. Positional myopia

37. Maximum correction of myopia can be done by– *(Recent pattern 2013)*

a. Radial keratotomy
b. LASIK
c. Photorefractive keratotomy
d. Orthokeratology

38. About degenerative myopia which of the following is true: *(AIIMS 2014, 2013)*

a. Myopic degeneration can lead to retinal detachment
b. It is more common in men than women
c. Less than -6 D
d. Optic disc swelling is seen

Most Recent Questions of 2019-2017 are given at the end

39. **Scarpa's Staphyloma is seen in** *(Recent pattern 2013-14)*
a. Retinal Detachment b. Myopia
c. Glaucoma d. Iridocyclitis

40. **The wavelength of laser (in nanometers) for shaping cornea in refractive surgery is:** *(All India 2012)*
a. 193 nm b. 451 nm
c. 532 nm d. 1064 nm

41. **A lady wants Lasik surgery for her daughter. She asks for your opinion. All the following things are suitable for performing lasik except**
a. Myopia of –4 diopters
b. Age of 15 years
c. Stable refraction for 1 year
d. Corneal thickness of 600 microns

42. **Which of the following type of lens is used for the treatment of myopia?** *(Recent pattern 2015)*
a. Converging lens b. Diverging lens
c. Cylindrical lens d. Toric lens

43. **1 mm change axial length of the eyeball would change the refracting power of the eye by–** *(Recent pattern 2015)*
a. 1D b. 2D
c. 3D d. 4D

44. **Pseudopapillitis is seen in –** *(Recent pattern 2014)*
a. Myopia
b. Hypermetropia
c. Squint
d. Presbyopia

45. **Shortening of 2 mm of axial length of eyeball causes** *(Recent pattern Nov/Dec 2016)*
a. 3D myopia b. 6D myopia
c. 3D hypermetropia d. 6D hypermetropia

46. **Regular astigmatism means:** *(Recent pattern 2015)*
a. The two meridians are perpendicular
b. The two meridians are parellel
c. Asymptomatic astigmatism
d. Astigmatism after cataract surgery

47. **Which type of refractive error is seen in keratoconus–** *(Recent pattern 2015)*
a. Irregular astigmatism
b. Regular astigmatism
c. Myopia
d. Hypermetropia

48. **What is irregular astigmatism –** *(Recent pattern 2015)*
a. Perpendicular principal meridians
b. Non perpendicular principal meridians
c. Any of the above
d. None of the above

49. **Astigmatism is due to–** *(Recent pattern 2014)*
a. Irregularity of curvature of cornea
b. Irregularity of curvature of lens
c. Forward displacement of the lens
d. Backward displacement of lens

50. **Anisometropia means–** *(Recent pattern 2016)*
a. Difference in corneal curvature in both meridian
b. High difference of refractive error between the two eye
c. Subluxation of one of the lens
d. Difference in image size of 2% in both eyes

51. **Aniseikonia means–** *(Recent pattern 2016)*
a. Difference in the axial length of the eyeballs
b. Difference in the size of cornea in both eyes
c. Difference in the size of pupil in both eyes
d. Difference in the size of image formed by the two eyes

52. **Treatment of choice for aniseikonia–** *(Recent pattern 2013)*
a. Orthoptic exercise
b. Spectacles
c. Surgery
d. Contact lens

53. **Which of the following is a sign of Aphakia–**
a. Shallow anterior chamber *(Recent pattern 2015)*
b. White pupillary reflex
c. Absent 1st and 2nd Purkinje images
d. Iridodonesis

54. **Jack in box scotoma is seen after correction of Aphakia by–** *(Recent pattern Dec 2012)*
a. IOL b. Spectacles
c. Contact lens d. None

55. **A 55-year-old male with a limbal scar presents to the ophthalmology clinic with markedly defective vision for near and far. Clinical examination reveals a wide and deep anterior chamber, iridodonesis and a dark pupillary reflex. A vision of 6/6 is achieved with correcting lens of +11D. Which of the following is the most likely diagnosis.** *(All India 2012)*
a. Aphakia b. Pseudophakia
c. Hypermetropia d. Posterior Dislocation of Lens

56. **A 35 year old male complains of vision distortion. The distortion increases progressively in both the meridians on wearing his spectacles. All of the following are correct regarding the patient's problem except:** *(AllMS Nov 2014)*
a. It is also called pincushion distortion
b. It is due to wearing of cylindrical glasses
c. It is due to asymmetrical convex lenses in both the eyes
d. It is aniseikonia

Determination of Refractive Errors

57. **Shadow test is used in –** *(Recent pattern 2015)*
a. Keratometry b. Ophthalmoscopy
c. Gonioscopy d. Retinoscopy

58. **Retinoscopy is done on a 0.5D myopia patient at a distance of 1 metre. Movement of the image will be–** *(AIIMS Nov 2001)*
a. Move with the mirror
b. Move opposite to the mirror
c. No movement of image with mirror
d. Image can move to any side

59. **No movement of Red reflex in retinoscopy–**
a. No refractive error *(Recent pattern 2015)*
b. Myopia of 3D
c. Myopia of 1D
d. Hypermetropia

60. **Methods to measure error of refraction are all except–** *(Recent pattern 2013)*
a. Retinoscopy b. Refractometry
c. Keratometry d. Binocular balancing

Most Recent Questions of 2019-2017 are given at the end

61. **Distance from which retinoscopy should be performed** *(Recent pattern 2013)*
   a. 25 cm b. 33 cm
   c. 50 cm d. 100 cm

62. **Jackson's crosscylinder test is used for–** *(Recent pattern 2015)*
   a. Subjective verification
   b. Subjective refinement
   c. Subjective balancing
   d. Objective refining

63. **The most convenient form of cross cylinder is a combination of–** *(Maharashtra 2010, Recent Question 2016)*
   a. –0.5 Diopter sphere with +1 Diopter Cylinder
   b. +0.5 Diopter sphere with –1 Diopter Cylinder
   c. +0.25 Diopter sphere with +0.5 Diopter Cylinder
   d. –0.25 Diopter sphere with +0.5 Diopter Cylinder

64. **Duochrome test is for–** *(Recent pattern Dec 2012)*
   a. Subjective verification of refraction
   b. Subjective refinement of refraction
   c. Subjective binocular balancing
   d. None

65. **Lensometer detects:** *(Recent pattern 2015)*
   a. Correct power of glasses
   b. IOP power
   c. Corneal topography
   d. Biochemical constitution of lens

Accommodation and Its Anomalies

66. **A 30 year old man has 6/5 vision each eye, unaided. His cycloplegic retinoscopy is +1.0 D sph. at 1 metre distance. His complaints are blurring of newsprint at 30 cm, that clears up in about 2 minutes. The most probable diagnosis is:** *(All India 2006)*
   a. Hypermetropia
   b. Presbyopia
   c. Accommodative inertia
   d. Cycloplegia

67. **Treatment of presbyopia–** *(Recent pattern 2013)*
   a. LASIK b. Concave lens
   c. Convex lens d. Radial keratotomy

68. **Patient with open angle glaucoma with 7D of myopia, complains of blurring of vision on administration of pilocarpine. What is the reason for the blurring?** *(Recent pattern 2015)*
   a. Small pupil
   b. Increased myopia asymmetry
   c. Increased hypermetropic asymmetry
   d. Increased astigmatism

69. **Muscles responsible for accommodation are innervated by nerves passing through?** *(Recent pattern 2013)*
   a. Pre-tectal nucleus b. Edinger-westphal nucleus
   c. Nucleus ceruleus d. Dorsal nucleus

70. **A 50 year old man complains of problem in his near vision. His vision is N-18 for both eyes which improved to N-6 on adding + 1 D sphere. Which would be the best immediate management of this patient?** *(AIIMS 2014)*
   a. Refractive correction with near add
   b. Cataract surgery
   c. Refractive correction under atropine
   d. Radial keratotomy

71. **True statement about accommodation:** *(PGI May 2013)*
   a. Mainly occurs due to change in curvature of posterior surface of lens
   b. Helps to improve stereopsis
   c. It is abolished by sympathomimetic drugs
   d. Produced due to an increase in curvature of the anterior surface of the lens
   e. Elasticity of capsule has bearing on accomodation

72. **All are true about presbyopia except:** *(PGI Nov 2011)*
   a. Common in young age group
   b. Not able to see near objects
   c. Spectacles having unifocal or bifocal lens should be used
   d. Correction of refractive error should be done
   e. Failure of accomodation

73. **Spasm of accommodation** *(Recent pattern 2016)*
   a. Caused by 1% tropicamide
   b. Caused by Pilocarpine
   c. Masquerades as myopia
   d. Treatment is with Pilocarpine

Miscellaneous

74. **Oculus Dexter refers to** *(Recent pattern 2013)*
   a. Left Eye
   b. Right Eye
   c. Both Eyes
   d. None of the above

75. **Ciliary musles are embryologically derived from** *(AIIMS Nov 2012)*
   a. Neural ectoderm b. Mesoderm
   c. Surface ectoderm d. Neural crest

76. **Which of the following is not a derivative of neural ectoderm?** *(AIIMS Nov 2013)*
   a. Retina b. Dilator pupillae
   c. Sphincter pupillae d. Ciliary muscles

77. **For refraction in a hypermetropic child, which is the best drug–** *(Recent pattern 2014)*
   a. Phenylephrine b. Atropine ointment
   c. Atropine drops d. Homatropine

78. **Concentration of tropicamide used in retinoscopy** *(Recent pattern 2014)*
   a. 0.01 b. 0.02
   c. 0.03 d. 0.04

79. **Which of the following are not cycloplegic drugs:** *(AIIMS Nov 2013)*
   a. Atropine b. Phenylephrine
   c. Tropicamide d. Pilocarpine
   e. Cyclopentolate

80. **Short acting mydriatics are:** *(AIIMS Nov 2011)*
   a. Atropine b. Homatropine
   c. Tropicamide d. Phenyephrine
   e. Cyclopentolate

81. **A 10-year-old complaints of headache. His best corrected visual acuity in the right eye is 6/36 and in the left eye is 6/6. Retinoscopy show +5D in right eye and +1D in left eye. All other ocular examination is normal. What is the possible diagnosis?** *(Recent pattern 2012)*
   a. Optic neuritis b. Cortical blindness
   c. Amblyopia c. Malingering

Most Recent Questions of 2019-2017 are given at the end

82. **Amaurosis fugax is due to –** *(Recent pattern Dec 2012)*
   a. TIA
   b. Tobacco
   c. Optic neuritis
   d. Papilloedema

Most Recent Questions of 2019-2017

83. **Prescription of presbyopic lens to a 50 year old emmetropic individual is** *(Recent pattern 2017)*
   a. +0.50
   b. +1.00
   c. +1.50
   d. +2.00

84. **What will be the prescription for spectacles in a patient having Simple myopic with the rule astigmatism?** *(Recent pattern 2017)*
   a. –0.5D at 180°
   b. +0.5D at 180°
   c. –3.0D at 90°
   d. +2.0D at 90°

85. **Which of the following is the best in case of an Amblyopia?** *(MCI Dec 2017)*
   a. Occlusion therapy
   b. Penalization
   c. Surgery
   d. Defer treatment till 10 years of age

86. **Stenopaeic slit can be used for all except** *(AIIMS May 2018)*
   a. Finchams test
   b. Iridectomy
   c. Corneal tattooing
   d. Axis of cylindrical refractory error

87. **What is the refractive status of a newborn?** *(MCI Dec 2017)*
   a. Myopic
   b. Hypermetropic
   c. Astigmatic
   d. Emmetropic

88. **If you look at a near object than what will happen** *(Recent question June 2018)*
   a. Lens becomes thin and more curved and dioptric power of lens increases
   b. Suspensory ligaments of the eye are stretched
   c. Ciliary muscle contracts
   d. Increase in tension on the lens

89. **Against the rule astigmatism is corrected with** *(Recent question Jan 2019)*
   a. –1.25 at 90 degree
   b. –2
   c. +2.5/+1.25 at 90 degree
   d. +0.25 at 90 degree

Most Recent Questions of 2019-2017 are given at the end

ANSWERS TO IMAGE-BASED QUESTIONS

1. Ans. (c) SMILE

Ref: American Academy of Ophthalmology, aao.org

SMILE is a minimally invasive, **FLAPLESS** procedure, FDA approved for treatment of myopia from –1.00 D to –8.00 D with ≤ –0.50 D of cylinder.

Using femtosecond laser, an intrastromal (corneal) lenticule is cut, which is then removed through small 2 mm incisions (being seen in the image). Bowman's layer is preserved.

2. Ans. (d) Subjective refinement of cylinder

Ref: Khurana optics 2/e, p. 153

The instrument seen in the image is the Jackson cross cylinder (over the trial frame) – which is used for subjective refinement of cylinder.

3. Ans. (b) Essential infantile esotropia

Ref: Pradeep Sharma 2/e, p. 189

In the image – the left eye of the infant has been patched – **Occlusion therapy** – done to prevent amblyopia – strabismic amblyopia occurs in large angle squint as in a case of non-accommodative Essential infantile esotropia.

Option a - Accommodative esotropia requires spectacle correction to overcome the refractive error.

Option c - Bilateral cataract does not require occlusion – if unilateral congenital cataract – anti-amblyopia therapy is a must.

4. Ans. (b) Refinement of cylindrical correction

Ref: Parson's 22/e, p. 68

The instrument seen in the image is the **Astigmatic fan**.

All the lines of the fan should look similar. If some of the lines appear clearer than others, it indicates inaccurate astigmatic correction, thus used for refinement of cylindrical error after retinoscopy and subjective adjustment by the Trial and error method.

5. Ans. (c) Lacquer cracks

Ref: Parson's 22/e, p. 326

Option a – a dark red circular patch at the macula, due to subretinal neovascularization and Choroidal hemorrhage **(white arrow)**.

Option b – due to the abnormal excessive growth of the eye, choroid, retina and vitreous undergo degenerative changes.

Initially, a tigroid/tessellated fundus appearance is seen – larger Choroidal vessels are visible.

Then, white atrophic patches (visible sclera) are seen **(black arrow)**.

Option c – cannot be seen here, they are fine criss crossing lines.

Option d – peripapillary atrophy / temporal myopic crescent – due to thinned or absent RPE. **(green arrow)**

6. Ans. (b) Primary angle closure glaucoma

The above image is most likely a case of Pathological/ Degenerative myopia (as explained in the previous question).

Option a – RRD is related to the severity of myopia, being much more common in high myopes.

(High Myopia is the most common cause predisposing to RRD.)

Option b – Primary open angle glaucoma, pigmentary glaucoma are seen as complications/associations of high myopia.

(The anterior chamber is deeper in myopia due to increased axial length.)

Option c – Vitreous hemorrhage is the most dreaded complication, it can be retinal, vitreous or Choroidal.

Option d – Foveal Retinoschisis (splitting of retina) occurs with posterior staphyloma, which is a sign of pathological myopia.

7. Ans. (a) The patient has a myopia of 7D, (c) Concave Contact lens are superior to spectacles for myopia correction in the patient, (d) It can be associated with Marfan syndrome

Option a/b – the patient with the above fundus image has Pathological myopia.

Such cases have Myopia >6D and Axial length >26 mm.

Option c – in high Myopia, contact lenses are a better treatment option than spectacles as they avoid peripheral distortion and minification produced by the strong concave spectacle lenses.

Option d – Systemic associations of High Myopia are

- Marfan syndrome
- Prematurity
- Noonan syndrome
- Pierre-Robin syndrome
- Ehlers-Danlos syndrome
- Stickler syndrome
- Down syndrome

Option e – Pathological Myopia has a prevalence of 2-3% in the general population.

8. Ans. (c) Emmetropia

The image is being formed on the retina, with both meridians having the same refraction.

9. Ans. (a) Posterior staphyloma

In the image (at the **marked arrows**, the posterior layers are seen to be bulging at those points, confirming the diagnosis of Posterior staphyloma (pathognomonic sign) and thus Pathological myopia. The retinoscopy values also correlate.

10. Ans. (d) Testing visual acuity in pre-school children

Sjögren's hand test is used for testing Visual acuity in verbal pre-school children (2-3 years of age group).

11. Ans. (c) Sjögren's hand figure test

Its obvious through the image. All that needs to be remembered is the list of visual acuity test to rule out the bogus option d – there is no test like Allen pre-school hand picture test.

12. Ans. (d) Myopia

Ref: Khurana 6/e, p. 38

13. Ans. (d) +20 D

Ref: Yanoff & Ducker 4/e, p. 89

- Instrument is indirect ophthalmoscope.
- Condensing lens commonly used is 20D biconvex lens.
- Magnification $= \frac{\text{Power of eye}}{\text{Power of lens}} = \frac{60D}{20D}$

$= 3$ times

14. Ans. (c) Retinoscopy

Ref: Parson's 22/e, p. 60

Streak retinoscopy being done from 1m distance, holding a lens in front of the eye the neutralize the movement to find the correct power

15. Ans. (c) Bifocal for pediatric aphakia

Ref: Diagnosis and Management of Ocular Motility Disorders by Alec M. Ansons, Helen Davis 3/e, p. 36

These are straight type/ executive type bifocals with a central lie dissecting the visual axis, such that the top of the reading segment passes just below the middle of the pupil when the eye is in the primary position. Indicated in

- Aphakia in children
- As low vision aids in children
- In selected cases of treatment od accommodative esotropia with convergence excess

Bifocals preferred in presbyopia/adults are usually D shaped

ANSWERS TO MULTIPLE CHOICE QUESTIONS

16. Ans. (c) 6 meters

Ref: Kurana 4/e, p. 13

- Snellen Chart can be used to measure visual acuity, usually read from a distance of 6 m./20 feet

17. Ans. (d) 50

(Ref: Parson's 22/e, p. 110; Elkington optics 4/e, p. 13; https://webvision.med.utah.edu/book/part-viii-gabac-receptors/visual-acuity/)

$$\text{Angle (in minutes of arc) subtended by each stroke of a letter} = \frac{\text{Viewing distance}}{\text{Distance at which each letter subtends 5 minutes of arc}}$$

Thus, for topmost letter – it subtends 5 minutes when viewed from 60 m and viewing distance in question is 6 m, so,
Angle (in minutes of arc) subtended by each stroke of the topmost letter when viewed from 6 m = 6/60 = 10 minutes of an arc
Also, snellen letters are constructed so that the size of the critical detail (stroke width and gap width) subtends 1/5th of the overall height, thus,

Total angle subtended by any letter at any distance should be equal to Angle (minutes of arc) subtended by each stroke of a letter multiplied by 5.

10 (minutes of arc) × 5 = 50 minutes of an arc

18. Ans. (b) Minimum resolvable

Ref: Khurana optics 2/e, p. 43

19. Ans. (b) Near the apex (C)

Ref: Khurana optics 2/e, p. 24

The prism produces displacement of the objects seen through it towards apex (**away from the base**).

20. Ans. (c) 4 D

Ref: Parson's 21/e, p. 49

$D = \frac{1}{f} = \frac{1}{0.25m} = 4D$

21. Ans. (a) 1.3 D

Ref: Khurana optics 2/e, p. 16

$D = 1/f$ meters

So,

$D = \frac{1}{0.75} = \frac{4}{3} = 1.3D$

22. Ans. (a) Distance between two focal points created by differential refractive power of lens or cornea in different meridians

Ref: A Simple Instrument for Explanation of sturm's Conoid George S. Zugsmith. X. George S. Zugsmith

It is an optical condition in which refractive power of cornea and lens is not the same in all meridians therefore instead of single focal point there are two focal points separated by focal interval, this is called sturms conoid The distance between two focal points is called sturms conoid interval.

23. Ans. (b) Optical center

Ref: John Forrester, Andrew Dick, Paul McMenamin, William Lee (1996). The Eye: Basic Sciences in Practice. London: WB Saunders Company Ltd. P. 28 ISBN 0-7020-1790-6

The point in the middle of a biconvex lens is called optical center.

24. Ans. (c) + 60 D

Ref: Khurana 3/e, p. 54; Parson's 20/e, p. 52

25. Ans. (a) Anterior surface of cornea

Ref: Cornea by Mannis p. 145

On average anterior cornea has refractive power of +48D of convergence and posterior cornea –5D of divergence.

26. Ans. (c) Curvature of the cornea

Ref: Optics of the human eye, p. 15-20

Cornea is the most important refracting medium responsible for convergence of light rays to the retina because of its curvature and difference in refractive index from air to comea.

27. Ans. (c) Centre of lens

Ref: Khurana optics, 2/e, p. 32

28. Ans. (b) Visual axis and optical axis

Ref: Khurana optics, 6/e, p. 32

29. Ans. (b) Object to fovea

Ref: Khurana 6/e, p. 31

Line joining fixation point, nodal point and fovea.

30. Ans. (c) 24 mm

Ref: Physics of human body 22/e, p. 642

31. Ans. (b) Hypermetropic

Ref: Parson's, 22/e, p. 76

In newborn, eyes are hypermetropic by + 2 to + 3D.

32. Ans. (a) Increase in length of the eye ball

Ref: Khurana 6/e, p. 38

33. Ans. (b) Myopia

Ref: Khurana optics 2/e, p. 76; Parson's 22/e, p. 256

- Seen in pathological myopia/degenerative myopia (Myopia > 6D or Axial length > 26 mm)

34. Ans. (d) Retinal detachment

- Most common complication of myopia is macular degeneration, followed by rhegmatogenous retinal detachment.
- *"Retinal detachment is the most dreaded and one of the most common complications of myopia". Duke –Elder*
- Most common cause of rhegmatogenous retinal detachment is pathological myopia

35. Ans. (b) Excimer Laser

Ref: Parson's 22/e, p. 74

36. Ans. (b) Index myopia

Ref: American Academy of Ophthalmology, BSCS Section 11/p. 43

- In early stages, progressive hardening of lens nucleus causes an increase in refractive index of lens causing a myopic shift (Index myopia)

37. Ans. (b) LASIK

Ref: Yanoff & Ducker 2/e, p. 786

- ***Correction of myopia:*** Extraction of clear lens (–16 to –18 D) > Phakic IOL (> –12 D) > LASIK (upto –12 D) > Radial keratotomy & PRK (–2 to 6 D).

38. Ans. (a) Myopic degeneration can lead to retinal detachment

Ref: Kanski 7/e, p. 637; Parson's 22/e, p. 72

- "Rhegmatogenous retinal detachment (RD) is much more common in high myopia, the pathogenesis including increased frequency of posterior vitreous detachment, lattice degeneration, asymptomatic atrophic holes. Macular holes and occasionally giant retinal tears. The prevalence of retinal detachment appears to be related to the severity of myopia."
- Optic disc swelling (pseudopapillitis) seen in hypermetropia.

39. Ans. (b) Myopia

Ref: Clinical ophthalmology By Sandeep Saxena 2/e, p. 445

'The presence of posterior staphyloma (Scarpa's Staphyloma) is pathognomonic of pathologic myopia'

40. Ans. (a) 193 nm

Ref: Yanoff 3/e, p. 43, 44, 45; Parson's 22/e, p. 608

Corneal Reshaping procedures such as photorefractive keratectomy (PRK) and Laser Assisted in Situ Keratomileusis (LASIK) are performed by laser in the ultraviolet wavelength of 193 nm to 213 nm. The most commonly used laser for such procedures is the Argon Fluoride Excimer Laser (ArF) with a wavelength of 193 nm.

41. Ans. (b) Age of 15 years

Ref: Khurana optics 2/e, p. 322; Parson's 22/e, p. 74

Minimum age for any refractive surgery should be at least 18 years

42. Ans. (b) Diverging lens

Ref: Elkington optics 4/e, p. 143; Parson's 22/e, p. 73

43. Ans. (c) 3D

Ref: Khurana 6/e, p. 35, Parson's 22/e, p. 70

44. Ans. (b) Hypermetropia

Ref: Parson's 22/e, p. 76

- Pseudopapillitis is seen hypermetropia.

45. Ans. (d) 6D hypermetropia

Ref: Khurana 6/e, p. 35; Parson's 22/e, p. 70

1 mm shortening of eyeball produce 3D hypermetropia.

46. Ans. (a) The two meridians are perpendicular

Ref: Eikington optics 4/e, p. 115; Parson's 22/e, p. 52

47. Ans. (a) Irregular astigmatism

Ref: Parson's 22/e, p. 76

Because of irregular corneal surface and conical cornea, irregular astigmatism usually occurs.

48. Ans. (b) Non perpendicular principal meridians

Ref: Parson's 22/e, p. 76

49. Ans. (a) Irregularity of curvature of cornea > (b) Irregularity of curvature of lens

Ref: Khurana optics 2/e, p. 79; Parson's 22/e, p. 52

- **Most common cause of astigmatism is abnormalities of curvature of cornea.** It is usually congenital
- Lenticular astigmatism is rare, seen in lenticonus (cone shaped lens), congenital tilling, oblique placement, traumatic subluxation of lens)

50. Ans. (b) High difference of refractive error between the two eye

Ref: Parson's 22/e, p. 78

Anisometropia is term used when dioptric power of both eyes are not the same, significant if > 2.5D difference.

51. Ans. (d) Difference in the size of image formed by the two eyes

Ref: Parson's 22/e, p. 283, 613

- Aniseikonia is defined as a condition where the images projected on the visual cortex from the two retinae are abnormally unequal in size or shape.

52. Ans. (d) Contact lens

Ref: Khurana optics 2/e, p. 84, Kanski 4/e, p. 814

- Up to 5 percent aniseikonia is well tolerated. For high degree of aniseikonia, treatment of choice is **contact lenses**.
- Aniseikonia due to unilateral aphakia corrected by IOL implantation.

53. Ans. (d) Iridodonesis

Ref: Parson's 22/e, p. 121

- Tremulousness of iris (iridodonesis) is seen in aphakia subluxation and shrinkage of lens.

54. Ans. (b) Spectacles

Ref: Parson's 22/e, p. 77

55. Ans. (a) Aphakia

Ref: 'Clinical Examination in ophthalmology' by Mukherjee (Elsevier, India) 2006 p. 163-164; Parson's 22/e, p. 77; Khurana optics 2/e, p. 66, 72

Markedly defective vision for both near and far, a deep anterior chamber, iridodonesis and a dark pupillary reflex all suggest a diagnosis of Aphakia. A limbal scar further points to the likelihood of surgical aphakia. Vision of 6/6 in aphakic eye can be achieved with a corrective lens of about 10D or 11D if the eye was previously emmetropic.

56. Ans. (b) It is due to wearing of cylindrical glasses

Ref: Khurana optics 2/e, p. 46

The **distortion increases progressively** in both meridians – the diagnosis has to be **Aphakia**, which causes spherical and prismatic aberrations as a side effect of high power convex spectacles.

On wearing cylindrical lenses i.e. correction of astigmatism, the distortion should decrease in both the axis, not increase.

57. Ans. (d) Retinoscopy

Ref: Parson's 22/e, p. 59

58. Ans. (a) Move with the mirror

Ref: Khurana optics 2/e, p. 131

Retinoscopy done at 1 m:

Against	No movement	With
<1D Myopia	1D Myopia	>1D Myopia Emmetropia Hypermetropia

59. Ans. (c) Myopia of 1D

Ref: Khurana optics 2/e, p. 131

60. Ans. (c) Keratometry

Ref: Khurana optics 2/e, p. 123

- Objective refraction methods are *retinoscopy*, refractometry and auto refractometer
- Binocular balancing is for conventional subjective refraction.
- Keratometry is for measurement of corneal curvature.

61. Ans. (d) 100 cm

Ref. Khurana optics 2/e, p. 166

62. Ans. (b) Subjective refinement

Ref: Khurana optics 2/e, p. 150–151

63. Ans. (a) –0.5 Diopter sphere with +1 Diopter Cylinder

Ref: Parson's 22/e, p. 67

- The most convenient form is a combination of a –0.5D sphere with a + 1.0D cylinder which has an effective strength of + 0.5D cylinder in one meridian and –0.5D in other.

64. Ans. (b) Subjective refinement of refraction

Ref: Khurana optics 2/e, p. 153

65. Ans. (a) Correct power of glasses

Ref: Yanoff and Ducker 4/e, p. 89

Lensometer/vertex meter – detects the vertex power-reciprocal of distance between back space of lens and secondary focal point. It rapidly measures power in all meridians and designates the major meridians to be prescribed.

66. Ans. (c) Accommodative inertia

Option a– (Correction factor for distance (d) from which retinoscopy is done $D = \frac{1}{d}$

Thus, for the patient, there is no refractory error.)

Option b– Presbyopia usually occurs at around 40 years of age, due to physiological insufficiency of accommodation, can not clear in 2 minutes

Option d– cycloplegia leading to loss of accommodation, will resolve in hours to day depending upon the drug used (10-20 days after atropine)

Option c– The accommodative system is slow in making a change and represents a case of accommodative inertia. 'Accommodative inertia refers to the delay in response of accommodation. Normally an accommodative change occurs in 1 sec."

67. Ans. (a) LASIK

Ref: Khurana optics 2/e, p. 102–103

Done by supplementing accommodation with convex lens of appropriate power to overcome problem of near vision.

68. Ans. (b) Increased myopia asymmetry

Ref: Manual of Ocular Diagnosis and Therapy p. 270

- Pilocarpine (Cholinergic drug) produces spasm of accommodation due to contraction of ciliary muscles.

↓

- This results in myopia (pseudomyopia) due to increased power of lens

↓

Worsening of myopia in already myopic patient

69. Ans. (b) Edinger-westphal nucleus

Ref. Parson's 22/e, p. 35

Pathway of accommodation reflex: The afferent impulses extend from the **retina to the parastriate cortex** via the optic nerve, chiasma, optic tract, lateral geniculate body, optic radiations, and striate cortex. **From the parastriate cortex the impulses are relayed to the Edinger- Westphal nucleus** of both sides via the **occipito-mesencephalic** tract and the pontine centre for convergence.

70. Ans. (a) Refractive correction with near addition

Ref: Khurana optics 2/e, p. 101–103

Here the patient is suffering from presbyopia (50 year old, problem in near vision) thus correction for near vision over correction of distance.

71. Ans. (d) Produced... & (e) Elasticity...

Ref: Parson's 22/e, p. 56

Accomodation has no role in stereopsis

Ocular Changes in Accommodation

"The shape of lens at any one time is thus result of a balance b/w its own elasticity & that of its capsule. The capsule is more elastic(than lens) & when the ciliary muscle contract the ciliary body approaches the lens, thus slackening the zonules so that the capsule relieved of tension, is able to mould the lens into its accommodated form" (Parson's 20/e, p. 58)

72. Ans. (a) Common in young age group

Ref: Khurana optics 2/e, p. 100–101

73. Ans. (c) Masquerades as myopia

Ref: Parson's 22/e, p. 79

Spasm of accommodation is caused by strong miotics such as ecothiophate and not generally due to Pilocarpine. The treatment is with Atropine.

Overacting accommodation leads to focus at near objects, thus induced blurring of vision for far (Pseudomyopia).

74. Ans. (b) Right Eye

Ref: Oxford American Handbook of Ophthalmology (Oxford University Press) 2010/XVIII; Clinical Examination in Ophthalmology by Mukherjee (Elsevier India, 2009) p. 22

Abbreviation	Name	Refers To
OD	Oculus Dexter	Right Eye
OS	Oculus Sinister	Left Eye
OU	Oculus Uterque	Both Eyes

75. Ans. (b) Mesoderm

Ref: Parson's 21/e, p. 5

76. Ans. (d) Ciliary muscles

Ref: Parson's 21/e, p. 5 (20/e, p. 51)

Ciliary muscles are derived from Neural crest and not neural ectoderm.

77. Ans. (b) Atropine ointment

Ref: Parson's 22/e, p. 79

- Atropine ointment (1%) is the cycloplegic of choice for refraction in a young child.

78. Ans. (a) 0.01

Ref: Parson's 21/e, p. 152

Tropicamide comes in 0.5% and 1% drops
1%=1/100=0.01

79. Ans. (b) Phenylephrine, (d) Pilocarpine

Ref: Khurana Optics 2/e, p. 137; Parson's 22/e, p. 155

Phenylephrine not used as cyclopegic for retinoscopy; used as mydriatic alone or in combination with tropicamide.

80. Ans. (c) Tropicamide & (d) Phenyephrine

Ref: Khurana optics 2/e, p. 136

81. Ans. (c) Amblyopia

Ref: Kanski 7/e, p. 744

Vision in right eye is 6/36 but the ocular examination is normal. This there is no organic cause for decreased vision (Anisometropic amblyopia due to > 2.5D difference in refractory power between the two eyes).

82. Ans. (a) TIA > (d) Papilloedema

Ref: Parson's 22/e, p. 619

- Amaurosis fugax is sudden temporary and painless loss of vision due to transient failure of retinal circulation.
- It may occur in carotid transient ischemic attack (TIA).

83. Ans. (c) +1.50

Ref: Khurana optics 2/e, p. 101, Elkington optics 4/e, p. 237

Rough estimate for presbyopic add

45 years: +1.00 to +1.25 D
50 years: +1.50 to +1.75 D
55 years: +2.00 to +2.25 D

In order to focus on an object at a reading distance of 25 cm, the emmetropic eye must accommodate by 4 D. However, for comfortable near vision one-third of the available accommodation must be kept in reserve. Therefore, the patient will begin to experience difficulty or discomfort for near vision at 25 cm when his accommodation has decayed to 6 D. This usually occurs between 40 and 45 years of age. A person experiencing such difficulty and discomfort for near vision due to reduced amplitude of accommodation is said to be *presbyopic.*

84. Ans. (a) –0.5D at 180°

Ref: Khurana Optics 2/e, p. 80

With the rule astigmatism – two prinicipal meridian are at right angles with the vertical meridian being more curved. Correction requires **Convex (+) cylinder at 90° or Concave (-) cylinder at 180°**
In the question Myopic astigmatism is given means the patient has to be given a concave [diverging (-)] cylindrical lens at 180°.

85. Ans. (a) Occlusion therapy

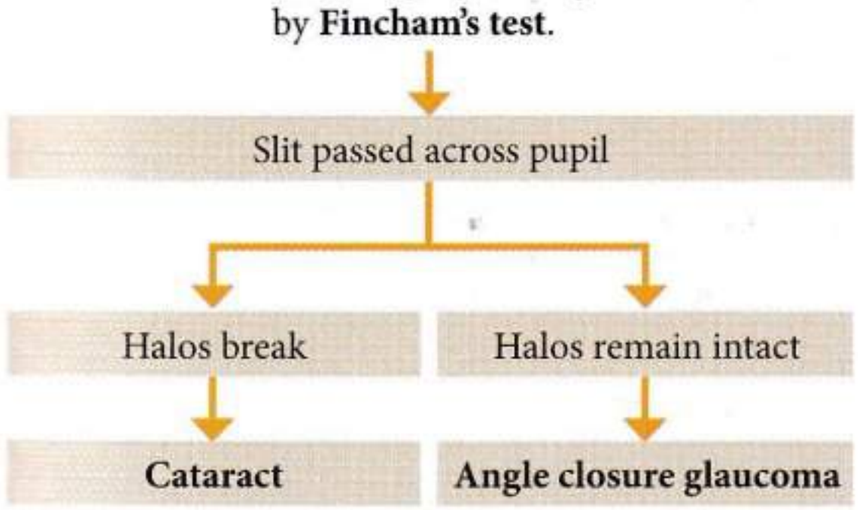
Ref: Parson's 22/e, p. 422

86. Ans. (c) Corneal tattooing

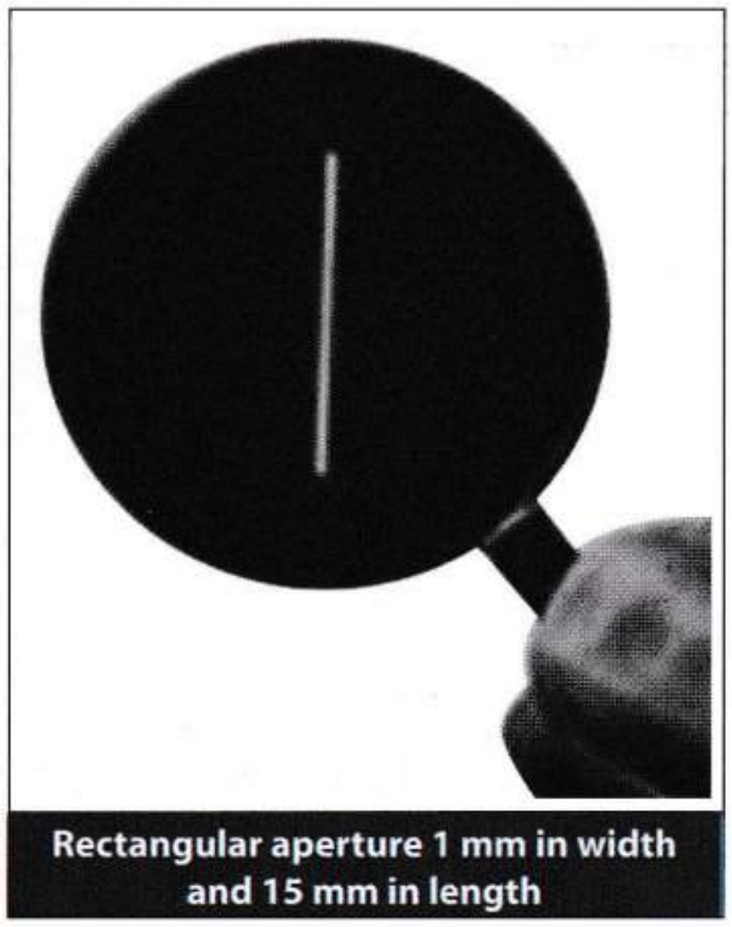
Ref: Elkington Optics 4/e, p. 117-118

Uses of Stenopaeic Slit

- Determination of **meridian of optical iridectomy** – in patients with corneal scar or lenticular opacity
- To diagnose cases of cataract, by differentiating between colored halos caused in Angle closure glaucoma and cataract by **Fincham's test**.



- Determine **power and axis of cylinder** – The slit aperture acts as an elongated 'pin-hole', only allowing light in the axis of the slit to enter the eye. Hence, when the slit lies in one principal axis of the astigmatic eye, the second line focus is eliminated and the blur of Sturm's conoid reduced thus allowing a clearer image to be formed.



Rectangular aperture 1 mm in width and 15 mm in length

87. Ans. (b) Hypermetropic

Ref: Khurana 6/e, p. 13

Eye at birth

Newborn is **Hypermetropic** by +2 to +3 D
Anteroposterior diameter is smaller (70% of adult) – 16.5 mm
Corneal horizontal diameter is smaller – 9.5 to 10 mm
Tears are not secreted
AC is shallow

88. Ans. (c) Ciliary muscle contracts

Ref: Parson's 22/e, p. 56; Khurana optics 2/e, p. 98-99

89. Ans. (a) –1.25 at 90 degree

Ref: Khurana optics 2/e, p. 80

ATR – Corrected with conVex (-) cylindrical lens at 180 degree or conCave (+) cylindrical lens at 90 degree

NOTES

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3

STRABISMUS

Chapter Outline

Classification of Strabismus
Directions of Deviation
Why does Strabismus occur?
- Extraocular muscles
  - Anatomy
  - Actions
- Binocular single vision

Consequences of Strabismus
Adaptations to Strabismus
Examination/Tests for Strabismus
Types of Strabismus
- Pseudostrabismus
- Heterophoria
- Heterotropia
  - Comitant Strabismus
  - Incomitant Strabismus

Supranuclear Control of Ocular Motility
- Gaze palsies

Myopathies

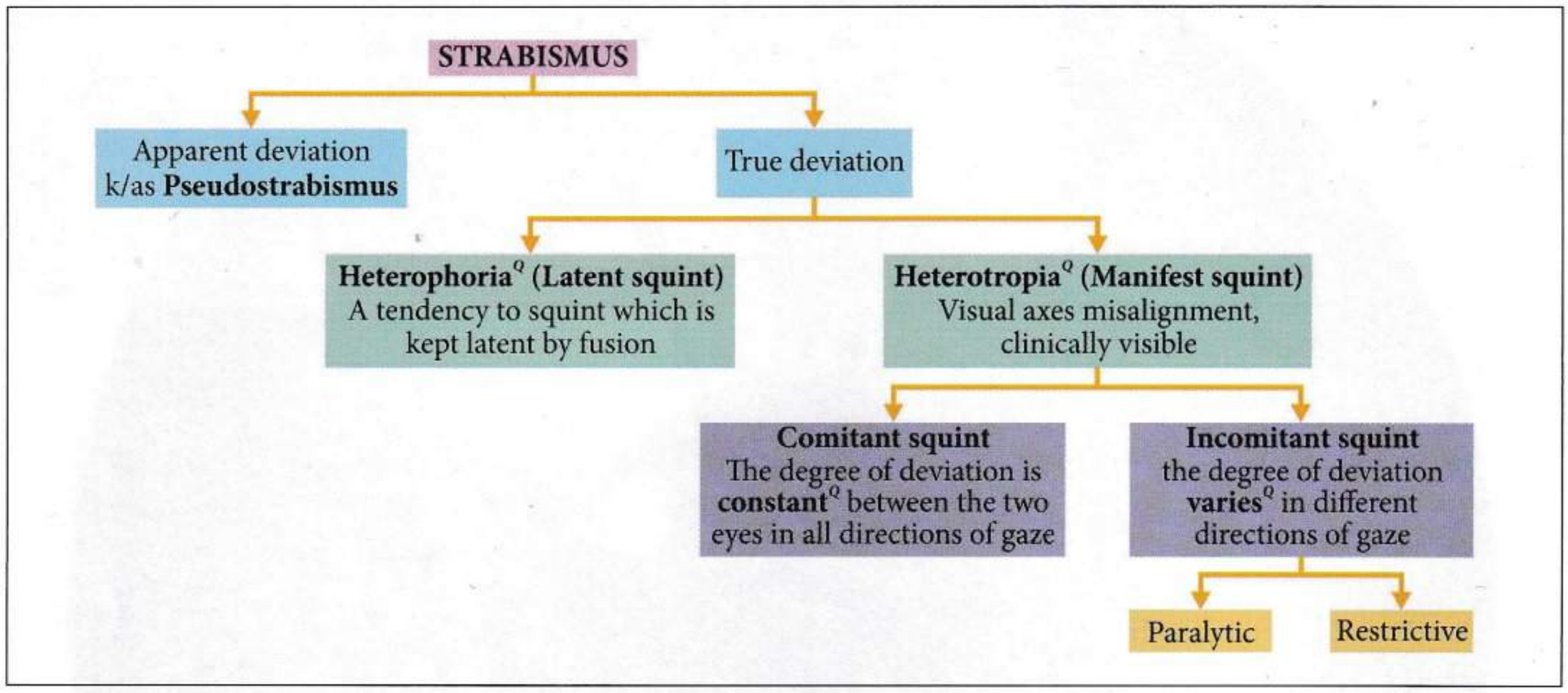
"I have an appetite for the normal in my life as well as the abnormal."

STRABISMUS/SQUINT

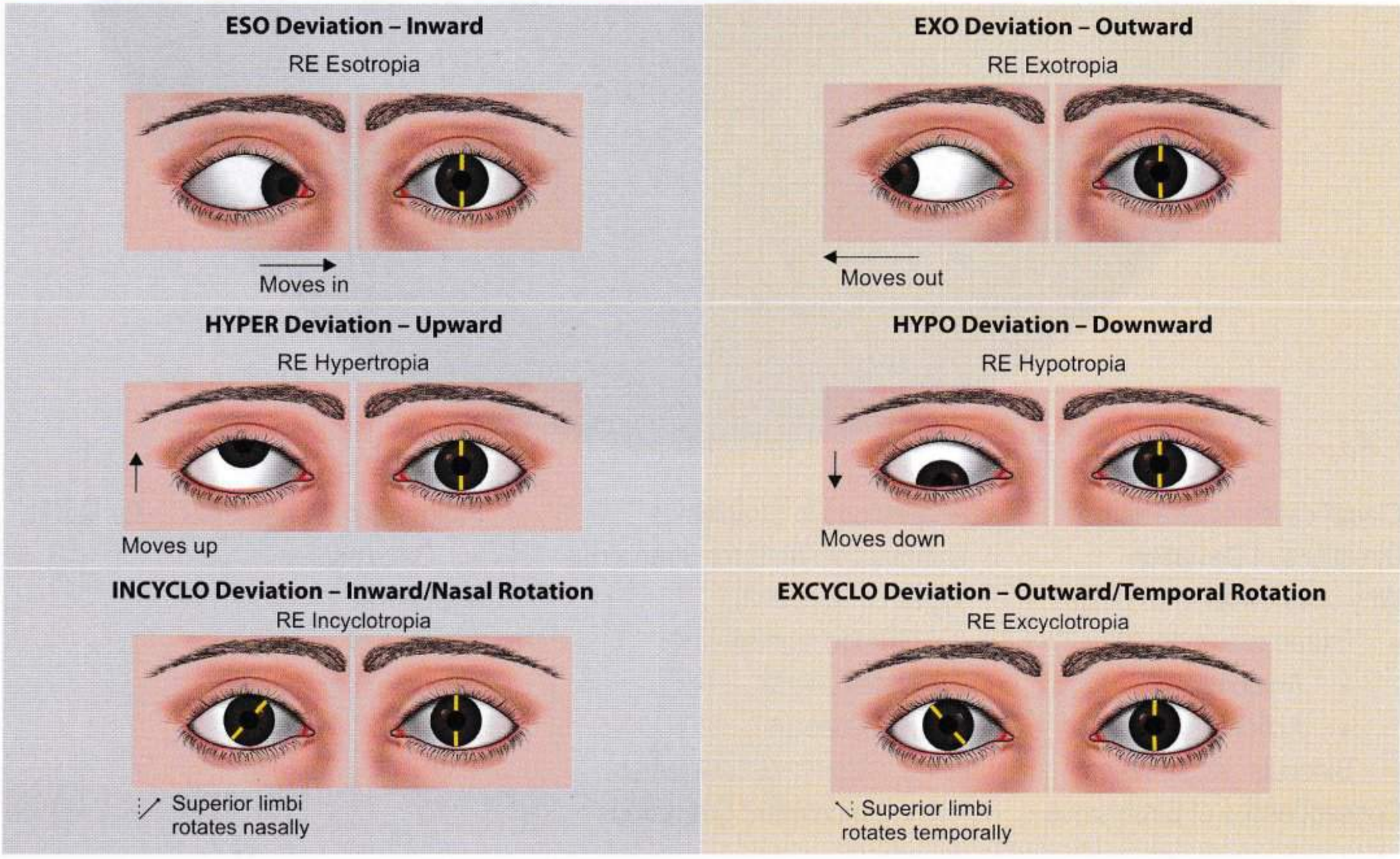
The condition where the visual axes of the two eyes do not meet at the point or object of fixation.

Simply put, strabismus is a condition when both the eyeballs do not look in the same direction, 'DEVIATION' of eyes, misalignment of eyes or crossed eyes.

Classification


STRABISMUS
Apparent deviation k/as Pseudostrabismus
True deviation
Heterophoria[Q] (Latent squint)
A tendency to squint which is kept latent by fusion
Heterotropia[Q] (Manifest squint)
Visual axes misalignment, clinically visible
Comitant squint
The degree of deviation is constant[Q] between the two eyes in all directions of gaze
Incomitant squint
the degree of deviation varies[Q] in different directions of gaze
Paralytic
Restrictive

Directions of Deviation



Mnemonic

ESO(N) ← NOSE – ESO means deviation toward the nose, i.e. inward

Why does Squint Occur?

Extraocular muscles (EOMs) are inserted onto the eyeball, controlling its movements like strings controlling puppets

↓

So, the EOMs enable both eyes to maintain the visual axes, thus any problem in their function manifests as a deviation causing squint

For the Sake of Simplification, Lets Consider 3 Scenarios

Scenario 1

EOM has a weakness/dystrophy/atrophy, etc.

↓

Concerned EOM cannot carry out its action

↓

Limitation of movement/deviation

↓

Squint

Scenario 2

EOM is normal, but nerve palsy present

↓

Paresis of action

↓

Squint

Scenario 3

EOM and nerve supply are normal, but restriction to movement is present, (e.g. musculofacial anomalies, orbital fracture)

↓

EOM cannot carry out its action

↓

Squint

Thus, we can conclude that a knowledge about EOM and the movements of eye is necessary to understand the Basics of Squint.

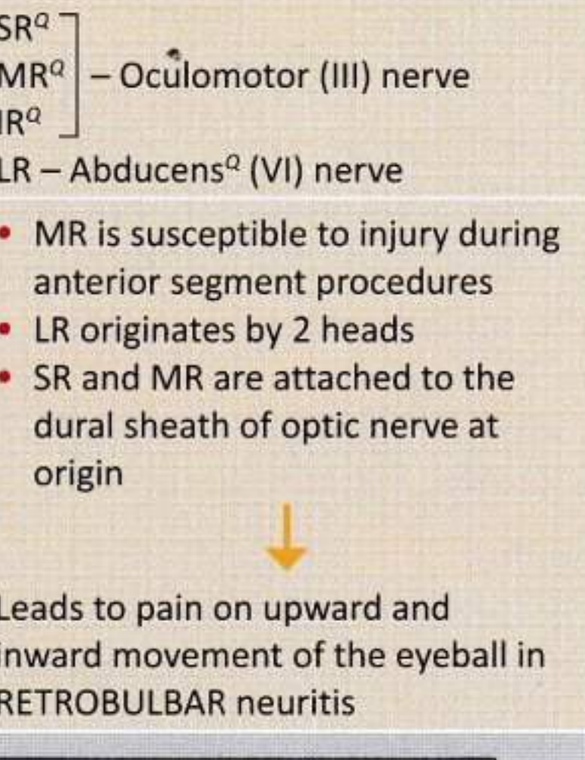
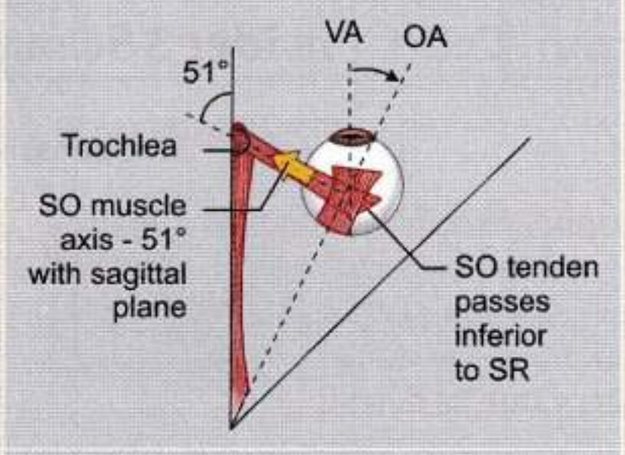
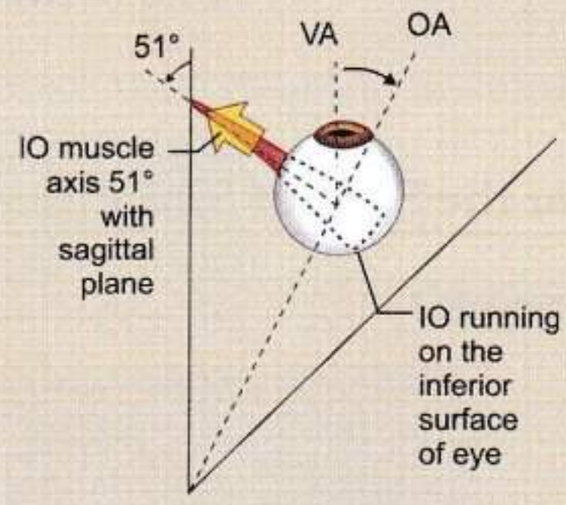
Correlate Box

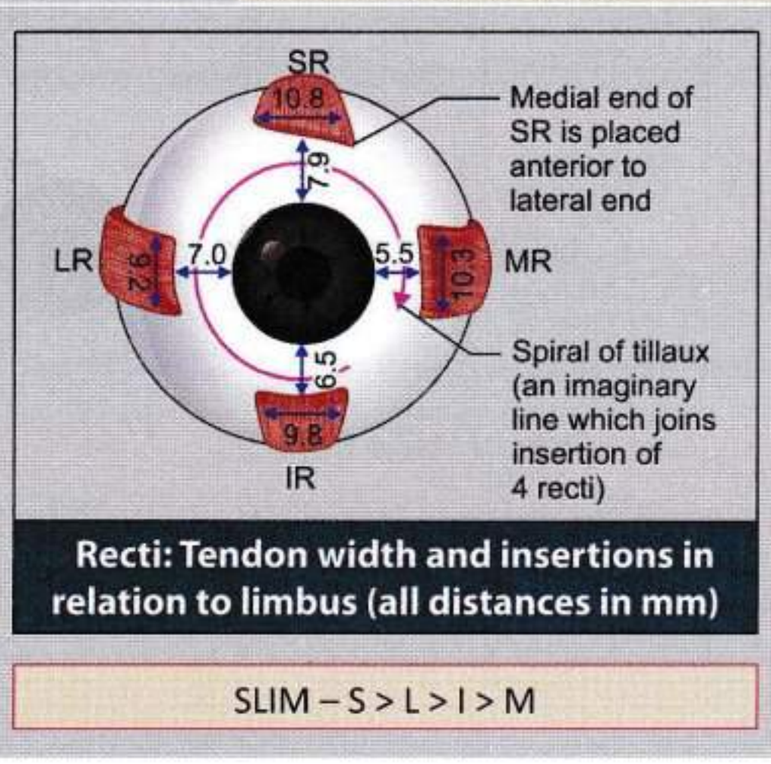
Muscles of the Eyeball

Extraocular-7		Intraocular-3
4 Recti 2 Oblique	Control the movement of eyeball	Ciliary muscle Sphincter pupillae Dilator pupillae
1 Levator palpebri superioris (LPS)		

EXTRAOCULAR MUSCLES

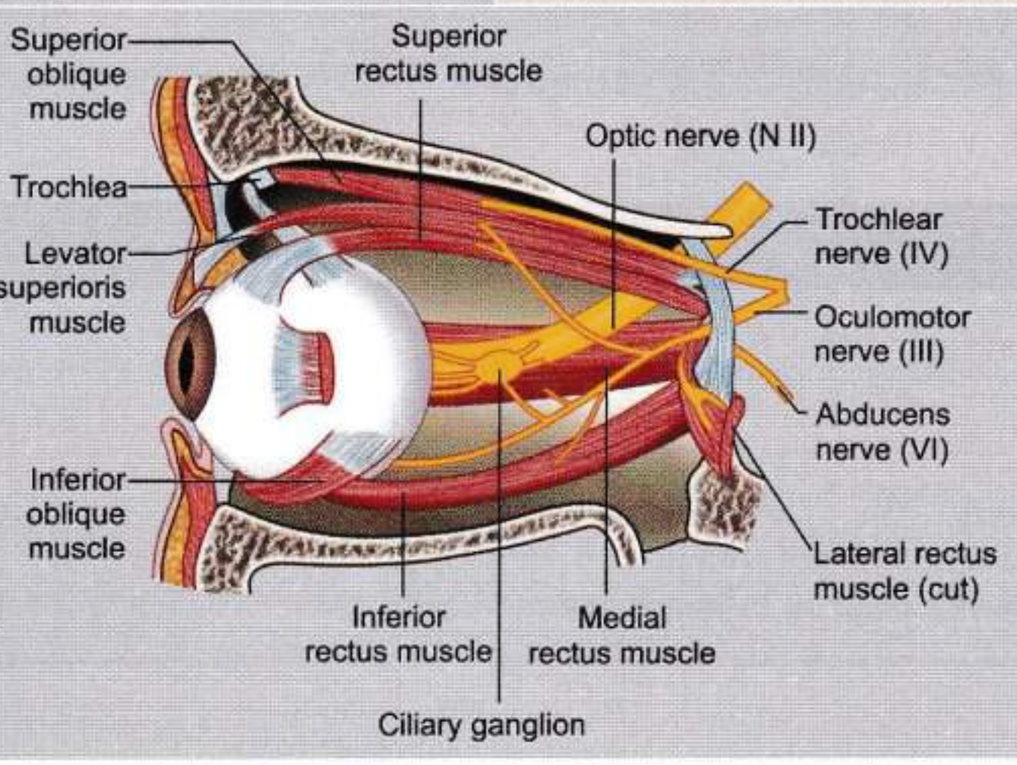
Anatomy

	Recti	Superior oblique (SO)	Inferior oblique (IO)
Origin	Common tendinous ring (**Annulus of Zinn**), attached to apex of orbit[Q].	• Body of sphenoid[Q], superomedial to optic foramen • Tendinous attachment of SR[Q]	Orbital surface of maxilla (anteroinferior)
Course	Run forward and diverge 	Runs forward up to **Trochlea** ↓ Turns **posterolaterally** at angle of 51° with sagittal plane ↓ Passes inferior to SR 	Ascends Posterolaterally[Q] ↓ **runs below[Q] the IR** 
Insertion	On the sclera, **in front[Q]** of equator at varying distances	On the sclera, in superolateral part, **Posterior[Q] to the equator**	On the sclera, in the inferolateral part, **Posterior[Q] to equator**
Nerve Supply[Q]	SR[Q], MR[Q], IR[Q] – Oculomotor (III) nerve LR – Abducens[Q] (VI) nerve	Trochlear (IV)[Q] nerve	Oculomotor (III) nerve[Q]
Anatomically significant points	• MR is susceptible to injury during anterior segment procedures • LR originates by 2 heads • SR and MR are attached to the dural sheath of optic nerve at origin ↓ Leads to pain on upward and inward movement of the eyeball in RETROBULBAR neuritis	• The **longest[Q]** and the **thinnest** EOM • Trochlea is the FUNCTIONAL origin • Only muscle to be innervated on the outer surface of belly ↓ Retrobulbar anesthetic block is not effective	• The **shortest tendon** • The **shortest EOM[Q]** • Related to inferior vortex vein near its insertion



Recti: Tendon width and insertions in relation to limbus (all distances in mm)

SLIM – S > L > I > M



Actions of Extraocular Muscles

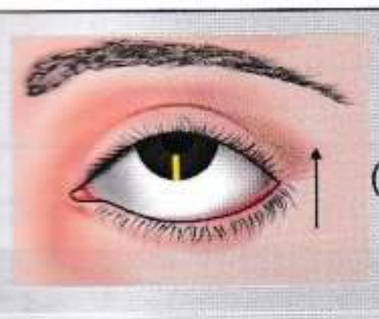
Actions of Extraocular Muscles in Primary Position

	1° (Primary)	2° (Secondary)	3° (Tertiary)
MR	ADDuction		
LR	ABDuction		
SR	Elevation	INtorsion	ADDuction
IR	Depression • Pure/maximum in 23° abduction	EXtorsion • Pure/maximum in 67° adduction	ADDuction
SO[Q]	INtorsion[Q]	Depression[Q]	ABDuction[Q]
IO	EXtorsion[Q] • Pure/maximum in 51° abduction • By anterior fibers of both obliques ↓ **1° actions of superior and inferior muscles more in ABduction**	Elevation[Q] • Pure/maximum in 39° adduction • By posterior fibers of both obliques ↓ **2° actions of superior and inferior muscles more in ADduction**	ABDuction

Mnemonic

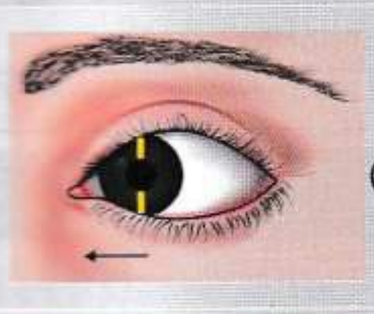
ABO
AB : ABduction by
O : Obliques

SIN
S : Superior muscles
IN : INtorters

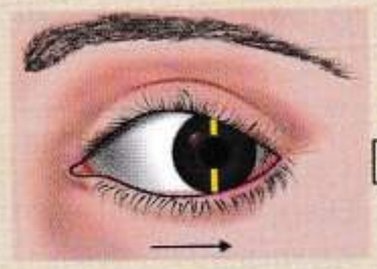


Elevation
(Upward movement)

Depression
(Downward movement)



Adduction
(Inward movement)



Abduction
(outward movemet)
'B' for bahar -out lateral

Intorsion
rotation of superior
limbi (12 o'clock) nasally

Extorsion
Rotation of superior
limbi (12 o'clock) temporally

Actions of extraocular muscles

Clinical Testing of Extraocular Muscles

- MR – Ask patient to look medially(in)
- LR – Ask patient to look laterally(out)
- SR – Ask patient to look upward and laterally(out) – Elevation in ABduction

Confusing Information!!!

We just read that the **anatomical function of SR is to elevate and ADduct** (move in),
but to clinically test we ABduct (ask to look out)

↓

Why so?

↓

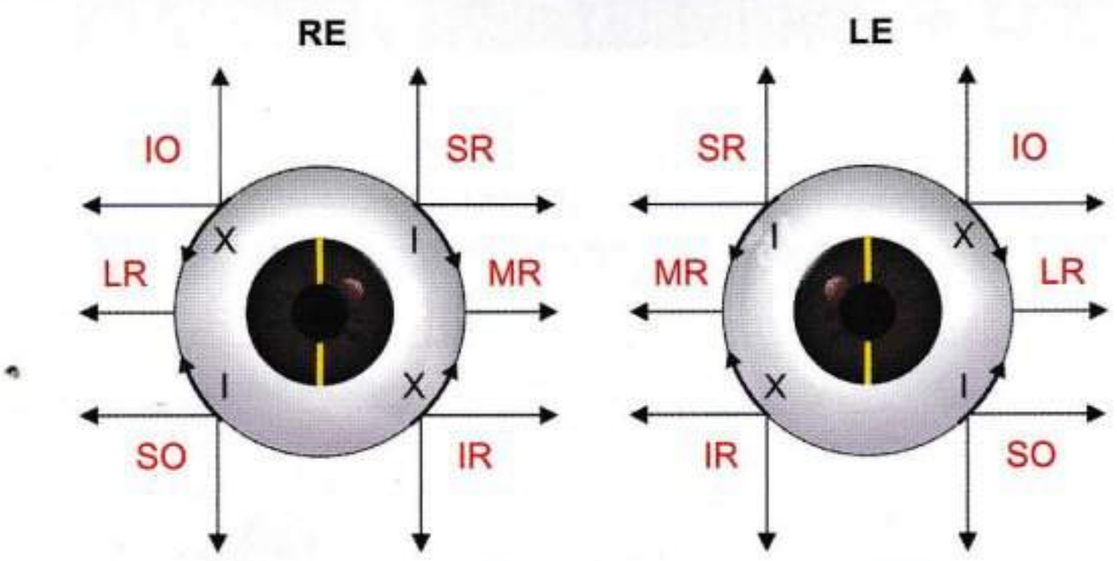
Because the normal angle between the muscle axis and visual axis is 23° (see figure in Anatomy of EOM),
so when eye is ABducted 23°, muscle axis and visual axis coincide

↓

SR becomes pure elevator

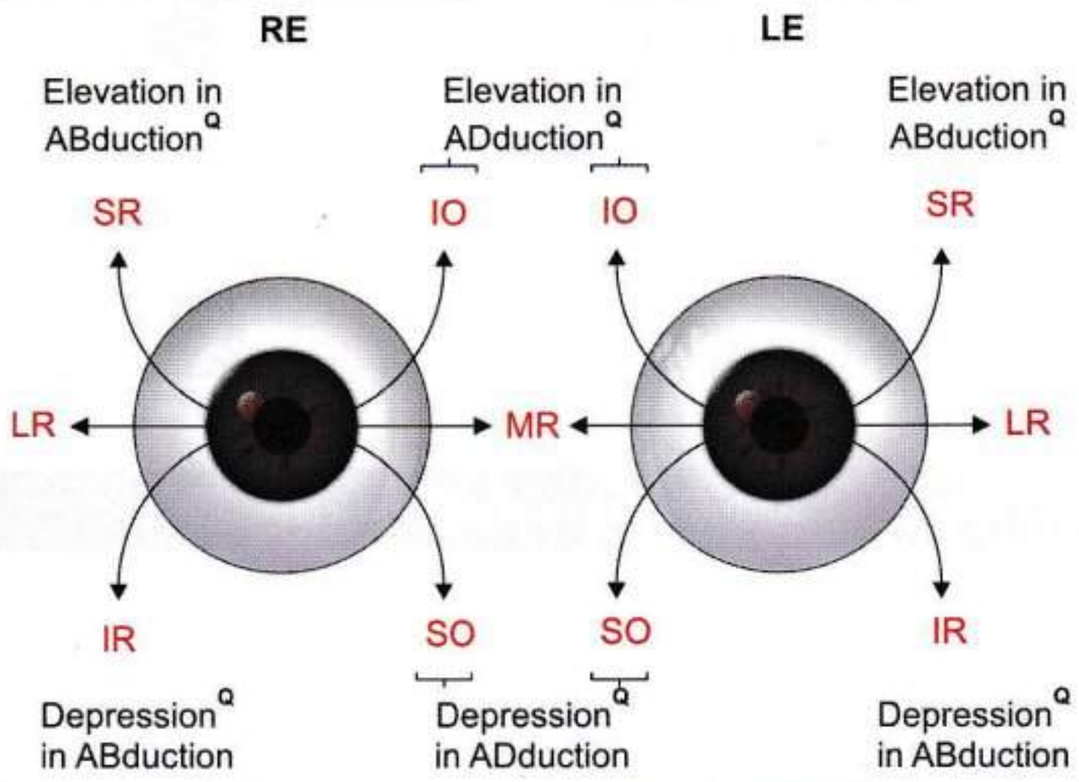
- IR – Ask patient to look downward and laterally(out) – Depression in ABduction
- SO – Ask patient to look downward and medially(in) **(Look at tip of nose)**^{Q} – Depression in ADduction
- IO – Ask patient to look upward and medially(in) – Elevation in ADduction

To summarize,



Anatomical functions

Abbreviations: IO, inferior oblique; IR, inferior rectus; SO, superior oblique; SR, superior rectus



Clinical functions

Abbreviations: IO, inferior oblique; IR, inferior rectus; SO, superior oblique; SR, superior rectus

Movements of Eye

Ductions

Mono-ocular[Q] movements, along the Listing's plane, around the Fick's axes

ABduction and ADduction	Horizontal plane	Z axis
Elevation and Depression	Vertical plane	X axis
Intorsion and Extorsion	Torsional plane	Y axis

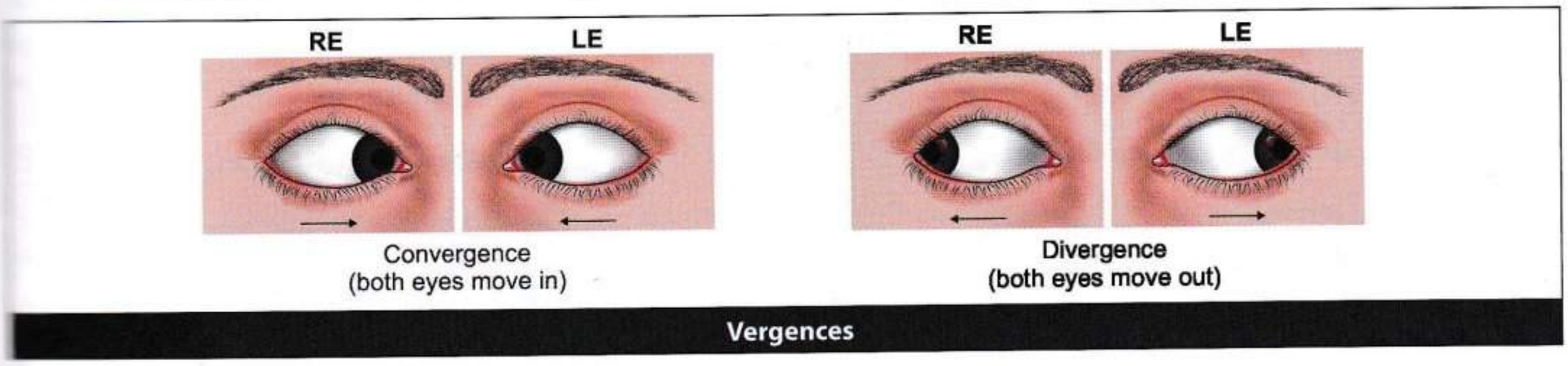
Versions

Binocular[Q], simultaneous movements in the same direction, i.e. **conjugate**[Q] movements

Eg. Dextroversion and Levoversion, Dextroelevation and Levoelevation, Dextrodepression and Levodepression, Sursumduction and Deorsumduction

Vergences

Binocular[Q], simultaneous movements in the **opposite directions**, i.e. **Disjugate** movement



Vergences

BINOCULAR SINGLE VISION

Both eyes should be co-ordinated in all their movements to be able to fixate upon the object of regard, such that the same image is formed on both fovea.

2 eyes – 2 fovea – 2 images → Single perception of object

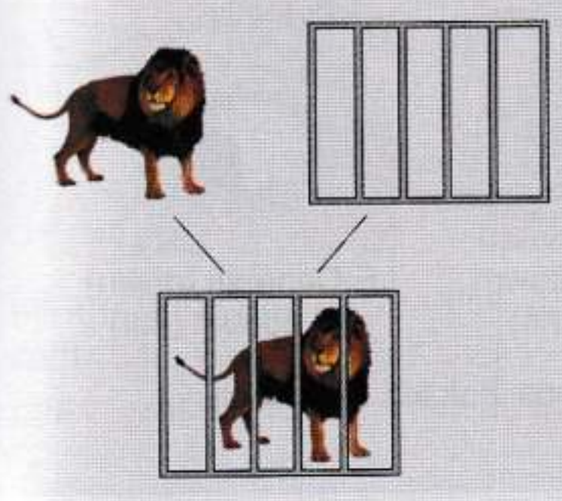
This is **BINOCULAR SINGLE VISION** (BSV)

Correlate Box

Grades of BSV (WORTH)

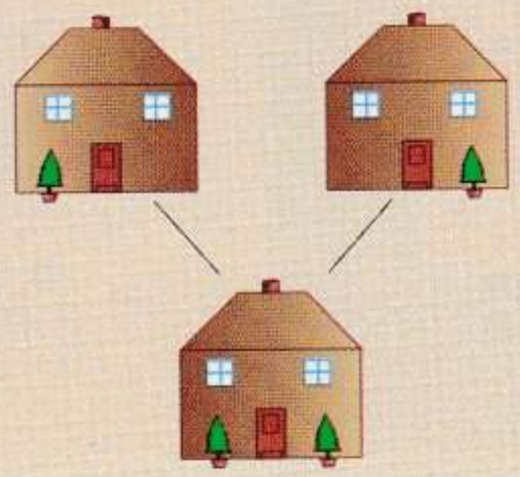
Grade 1 – SP (Simultaneous Perception)

Perception of visual impulses (similar or dissimilar) **simultaneously by the visual cortex** upon transmission from both eyes



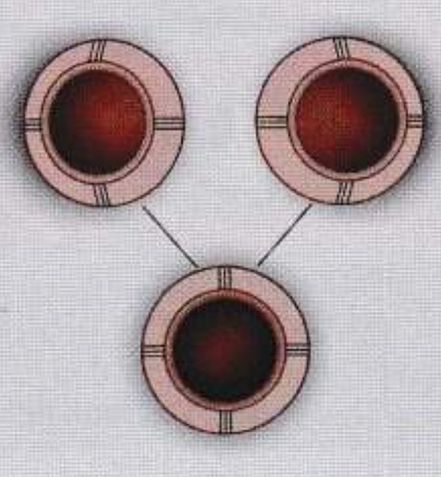
Grade 2 – FUSION

Ability of two eyes to produce a **single composite image from two similar images**, which are incomplete and different from each other in one small detail



Grade 3 – STEREOPSIS

- Ability to **obtain an impression of depth**
- It is 'INNATE'
- Possible by fusion of signals from retinal disparate elements



What enables BSV?

To understand, lets familiarize ourselves with some terms

Antagonists

Muscles having ***opposite action*** **in** ***same eye***
E.g. RMR and RLR, RSR and RIR, RSO and RIO

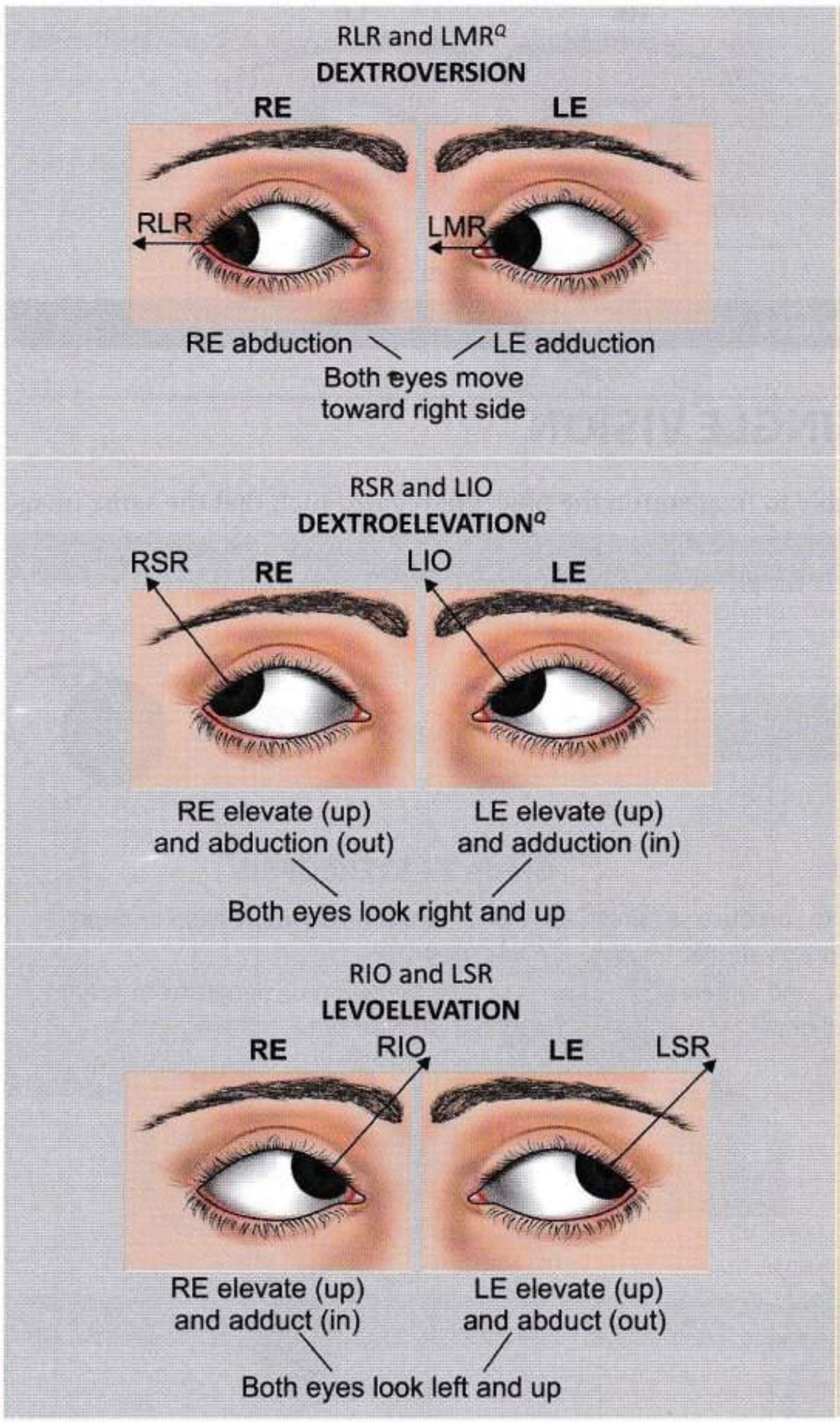
Synergists

Muscles having ***same action*** **in** ***same eye***
E.g. RSR and RIO, RIR and RSO

Yoke Muscles – (Contralateral Synergists)

A pair of muscles (**One in Each Eye**) which help to perform a **Conjugate/Version** movement, i.e. help to move both eyes in the same direction.

Example: Based on clinical functions



Bilateral SR & IO	Bilateral IR & SO
SURSUMVERSION[Q]	**DEORSUMVERSION**

Mnemonic

Q: What is the *yoke muscle* for RSR?
A: *FLIP THE NAME (For pair iii, iv, v & vi)*

Right	Superior	Rectus	(R S R)
↓	↓	↓	↓↓↓
Left	Inferior	Oblique	(L I O)

Hering's Law

Hering's law[Q] of equal innervation states that equal and simultaneous innervation flows to a pair of yoke muscles during any conjugate movement or disjugate movement (like convergence)

Clinical Applications

- Secondary deviation
- Inhibitional palsy

Exception to rule

- Dissociated vertical deviation (DVD)

Sherrington's Law

Sherrington's law[Q] of reciprocal inhibition states that during any binocular movement, the antagonist muscles (of the pair of yoke muscles) receive decreased innervation.

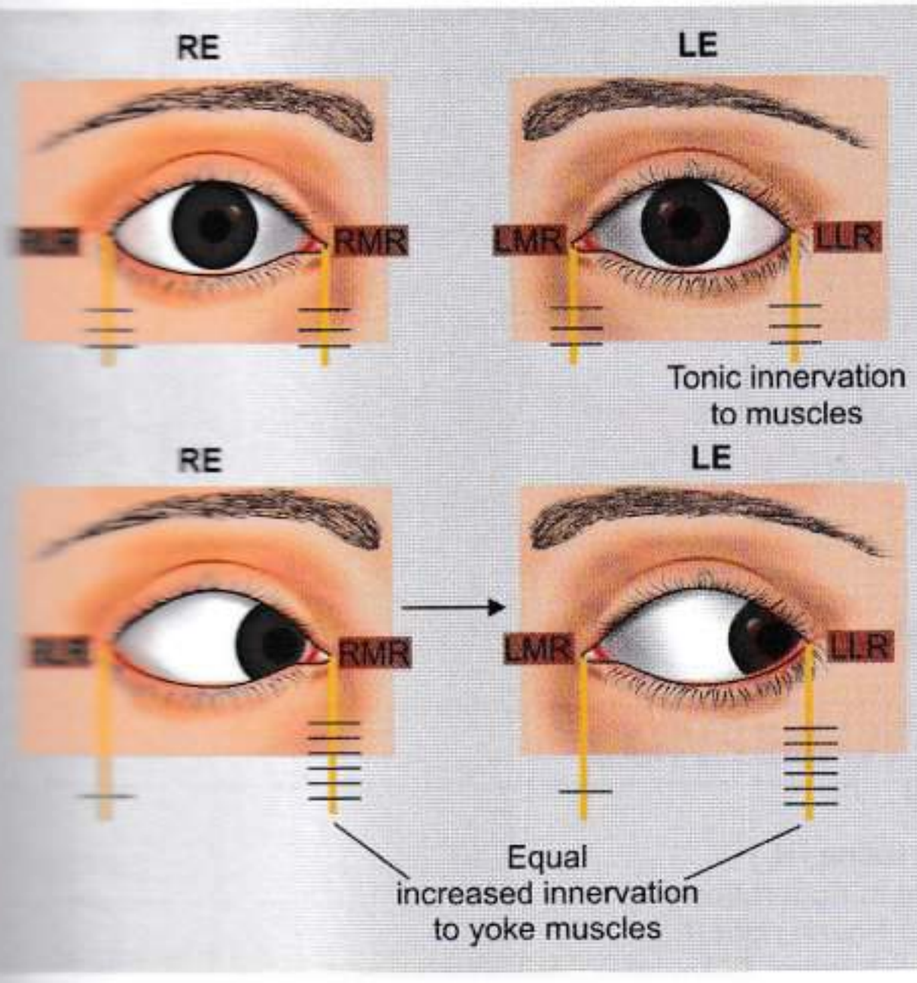
Clinical Applications

- During surgical manipulation of EOMs

Exception to rule

- Duane's retraction syndrome

Lets Summarize BSV



For Levoversion RMR and LLR are yoke muscles

↓

In order for Binocular movement to occur

↓

RMR and LLR receive simultaneous, equal increased innervation (Hering's law)

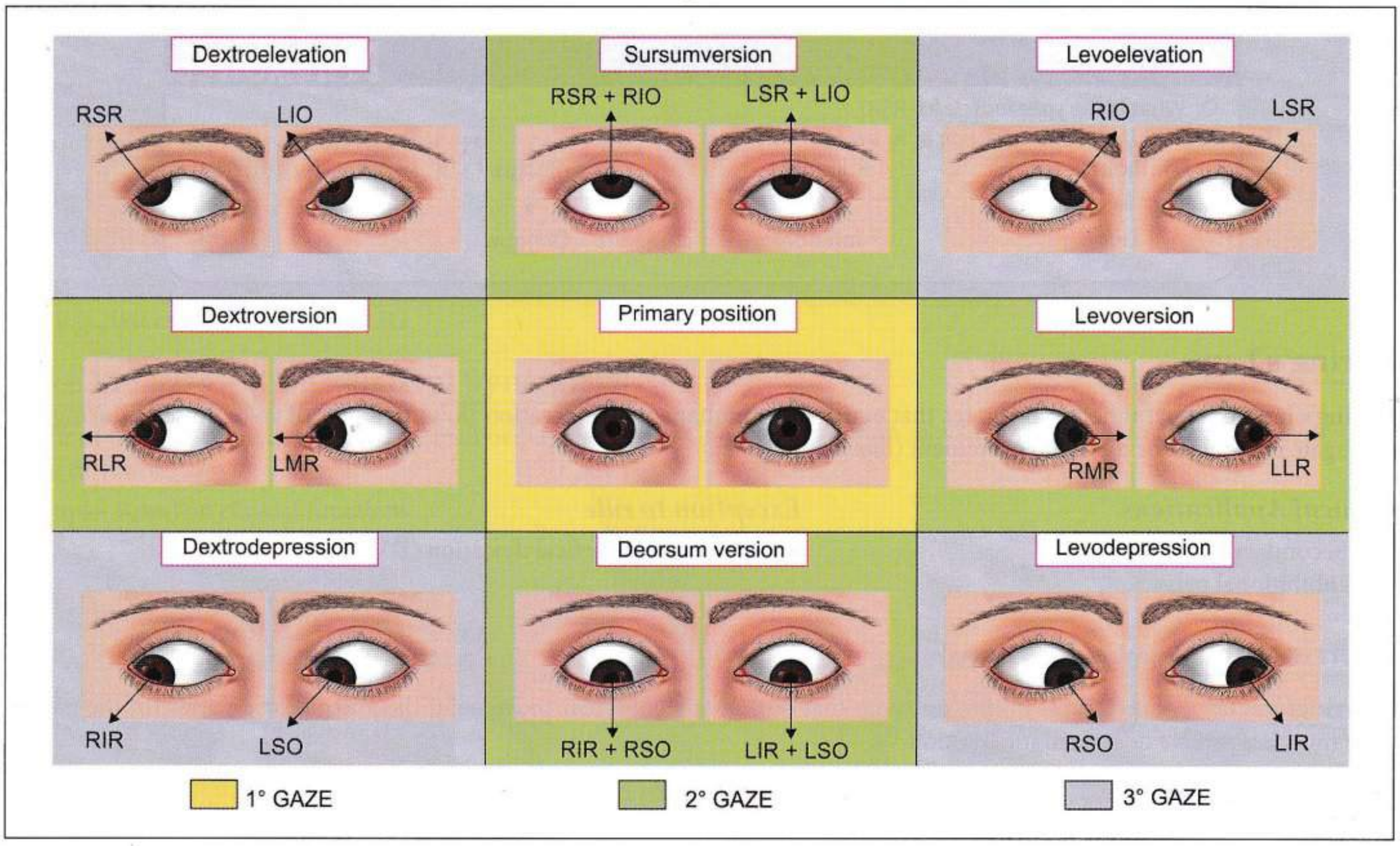
↓

Also, RLR (antagonist of RMR) and LMR (antagonist of LLR) receive decreased innervation (Sherrington's law)

Thus for any binocular movement, at least 4 muscles act together:

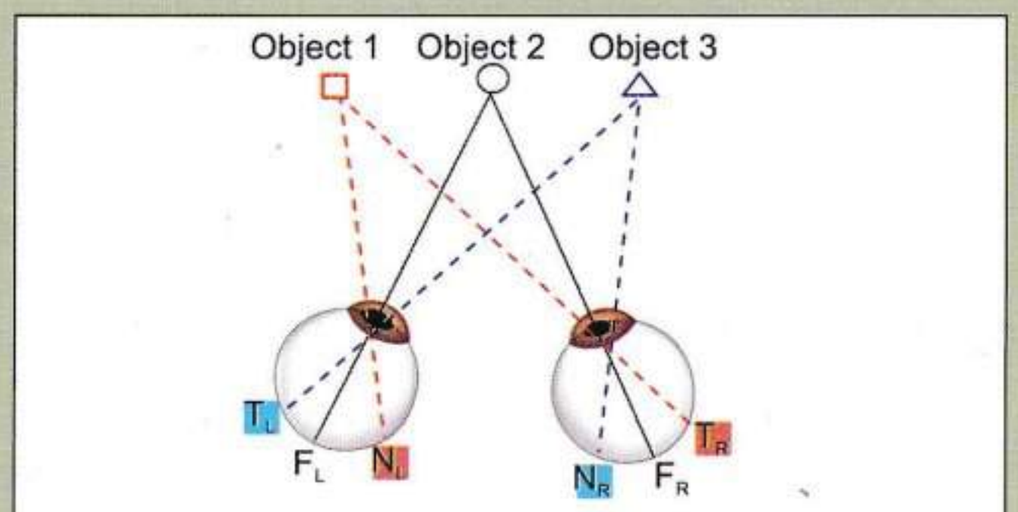
- Contract – yoke muscles and
- Relax – antagonists to yoke muscles

Directions of Gaze



Extra Mile

- **DONDER's law** – states that for each 3° position of eye, there is a single definite orientation of horizontal and vertical meridians, irrespective of the path of movement.
  Simply put, on moving eye from 1° gaze to 3° gaze, REAL TORSION does not occur, only PSEUDOTORSION occurs.
- **CORRESPONDING points** – are areas on each retina that have the same visual direction (e.g. fovea of both eye), such that the images on these points are perceived binocularly single.


Object 1
Object 2
Object 3
T_L
F_L
N_L
N_R
F_R
T_R
For object 1 - Nasal point in left retina (N_L)
and temporal point in right retina (T_R)
For object 2 - Fovea left (F_L) and Fovea right (F_R)
For object 3 - Temporal point in left retina (T_L)
and nasal point in right retina (N_R)

Corresponding points

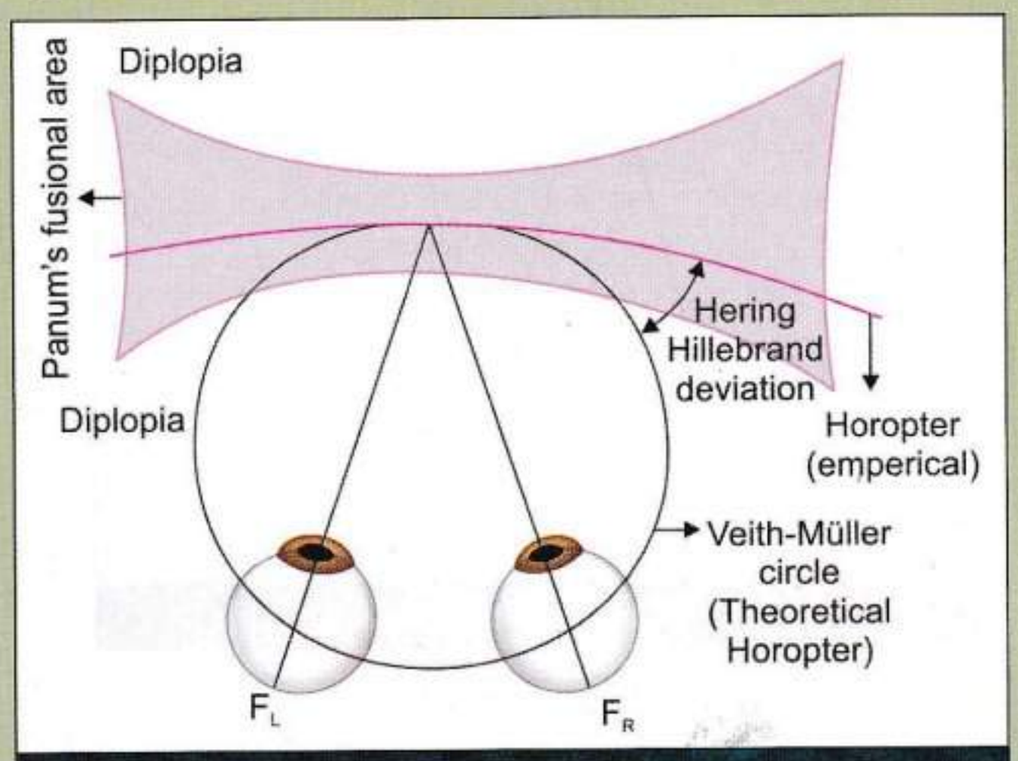
Contd...

EXTRA MILE

- **HOROPTER** – an imaginary plane in space, (for a given fixation target), all points on which project images to corresponding retinal points and are seen as binocularly single.
  - Theoretical – circular k/as VEITH-MÜLLER CIRCLE
  - Empirical – flattened

The difference between the two is known as HERING – HILLEBRAND DEVIATION.

- **PANUM FUSIONAL SPACE** field in front and behind of horopter, in which objects stimulate noncorresponding retinal points, but can be binocularly fused.
- PANUM's area is the basis of our depth perception and physiological diplopia.

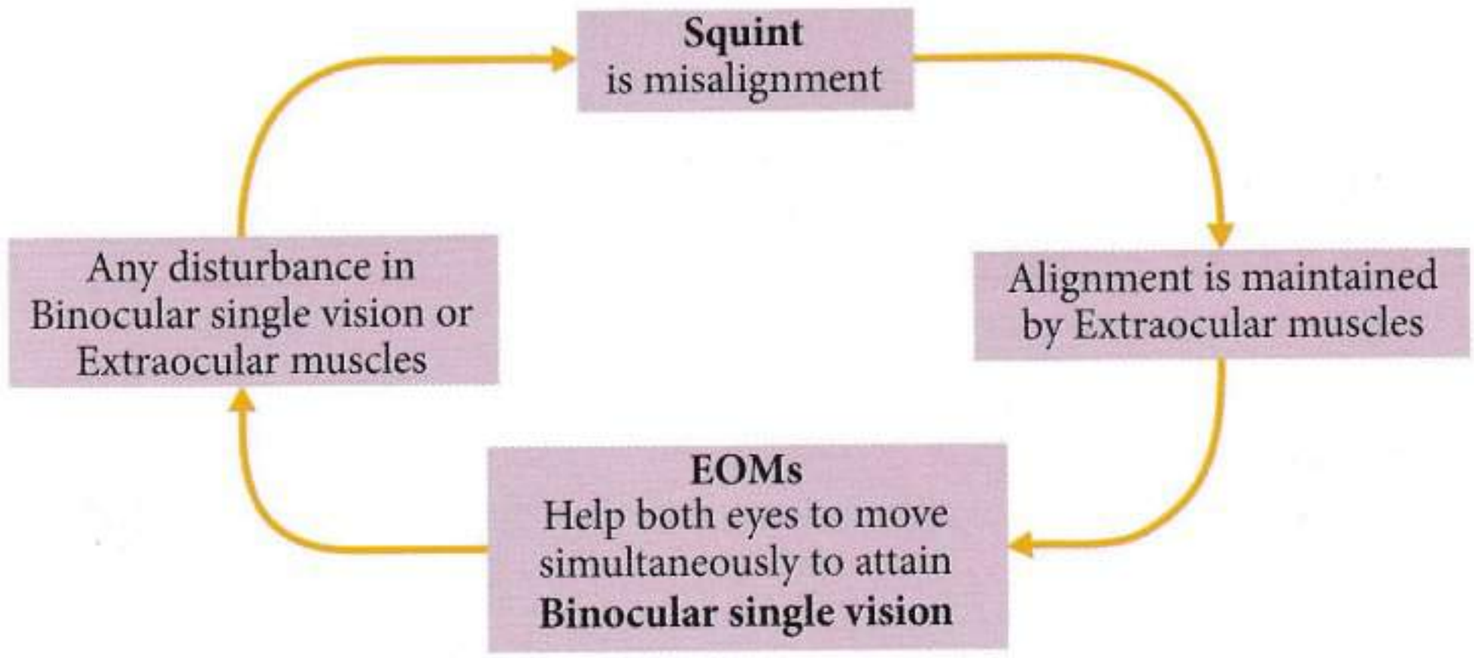


Panum fusional space

HIGH YIELD

- Objects on horopter – seen singly in one plane
- Objects in Panum's area – seen singly and stereoscopic
- Objects outside Panum's area – appear double (DIPLOPIA)

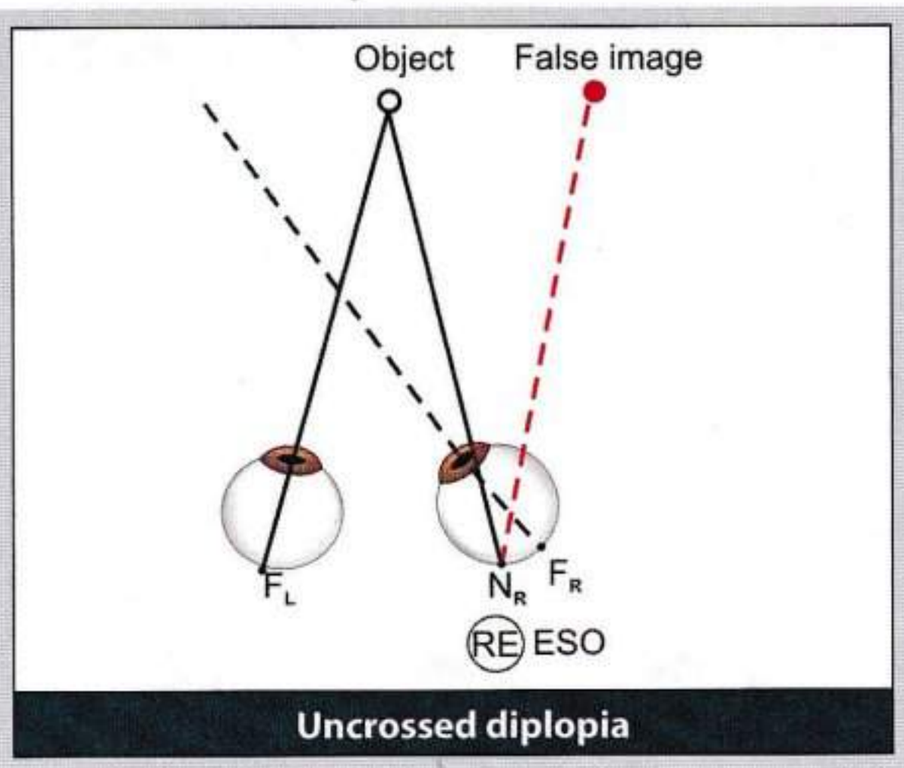
From the above **discussion so far, we understand that,**



CONSEQUENCES OF SQUINT

Diplopia

- **2 images of 1 object** are seen
- Occurs due to images of the same object falling on noncorresponding points
- Seen in cases of **Small-Angle squint**



Uncrossed diplopia

RE ESODEVIATION

Image formed on nasal retina

↓

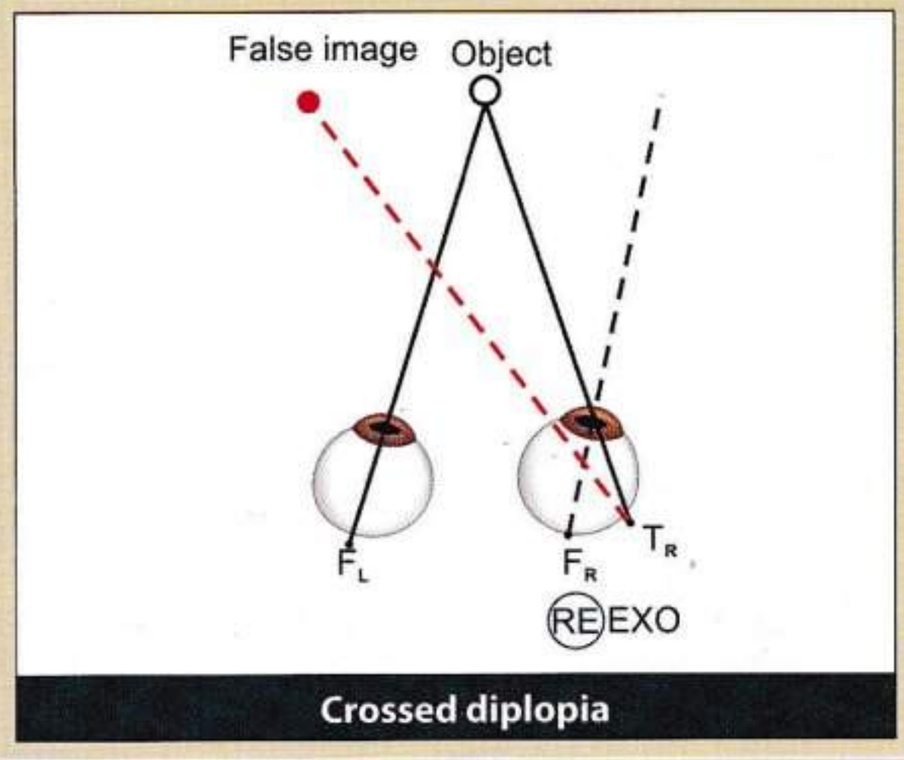
Projected in temporal visual field

↓

Right image visible on right side

↓

UNCROSSED



Crossed diplopia

RE EXODEVIATION

Image formed on temporal retina

↓

Projected into nasal visual field

↓

Right image visible on left side

↓

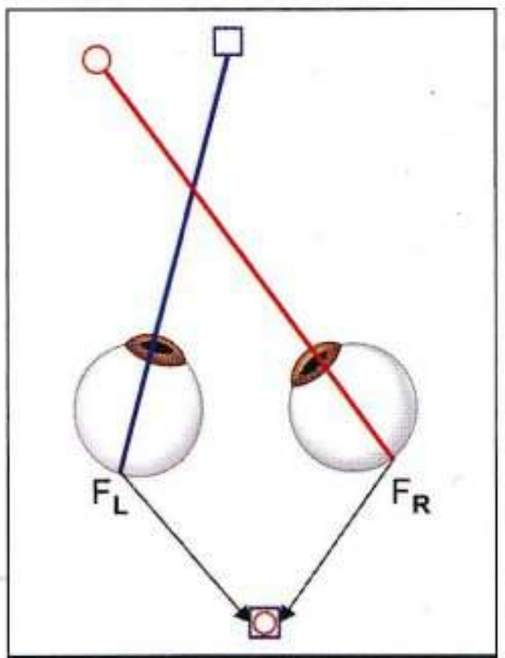
CROSSED

HIGH YIELD

- Cause of crossed diplopia – 3rd CN palsy
  Paralysis of ADductors (MR, SR, IR)
- Cause of uncrossed diplopia – 6th CN palsy[Q]
  Paralysis of ABductors (LR, SO, IO)
- **MC cause of binocular diplopia → Squint**[Q]
- **MC cause of mono-ocular diplopia → Cataract**

Confusion

- **2 images of 2 different objects** are seen
- Occurs due to both eyes fixating on different objects, leading to formation of 2 dissimilar images on corresponding points (fovea)
- Seen in **Large-Angle** squint



Confusion

ADAPTATIONS TO SQUINT

Our body has inherent mechanisms to adapt against pathological disruptions, the simplest being generation of fever in infection. Similarly, our body adapts to squint in two ways

Motor Adaptations

Fusion	Abnormal Head posture	SWAN's Blind Spot Mechanism
The extra strength of EOM, which helps to overcome retinal image disparity by performing vergence movements. **E.g.** In EXOPHORIA – the tendency for divergence is controlled by extra innervation to MR	Occurs in **Incomitant Squint** It has **3 components** • Vertical – Chin (elevate or depress) • Horizontal – Face turn • Torsional – Head tilt	Image of the deviating eye falls on the blind spot (if deviation 15-20°) – so does not cause diplopia

Sensory Adaptations (Only up to 6 yrs of age)

Anomalous Retinal Correspondence (ARC)	Suppression
In **Small Angle** squint ARC is recalibration of corresponding points ↓ Fovea of one eye corresponds with extrafoveal area of second eye	In **Large Angle** squint ↓ Cortical mechanism involving active inhibition of image from deviating eye ↓ **Amblyopia** of deviated eye

EXAMINATION OF SQUINT (TESTS)

I. **Visual acuity assessment and Refraction** – under cycloplegia with atropine must for children less than 5 years of age

II. **Head Posture Observation**

Causes of Abnormal Head Posture

- Paralytic squint
- Nystagmus
- Restrictive squint
- One-eyed patient
- A or V phenomenon

HIGH YIELD

Cycloplegic choice – <5 years – atropine 1% ointment TDS × 3 days

Cycloplegic choice – Adults – Cyclopentolate 1%

EXTRA MILE

Face turn toward right:

- Rt lateral rectus palsy[Q]
- Rt medial rectus contracture
- Duane syndrome types I and III (Rt eye)
- Lt medial rectus palsy

Causes of elevation of chin are

- Ptosis and pseudoptosis
- Paralysis of elevators of the eyeball
- Overaction of depressors
- Loss of the upper field
- High ametropia with correction:
  - Spectacle corrected aphakia
  - High myopia
- Double elevator palsy

Face turn toward left:

- Rt medial rectus palsy
- Left lateral rectus palsy
- Left medial rectus contracture
- Duane syndrome types II and III

Causes of depression of chin are

- Paralysis of depressors of the eyeball
- Overaction of elevators of the eyeball
- Loss of lower field of vision
- Double depressor palsy
  - Abnormal chin position without turning or tilting is due to ptosis, loss of field or high ametropia
  - Abnormal chin position with tilting and turning of the head is due to abnormality of cyclovertical muscles

III. **Examination of ocular movements (ductions and versions) done in 9 cardinal gaze positions.**

IV. **Measurement of Vergences**

- Squint manifests only when fusion (fusional vergence) is overcome.
- Measurement can be done by
  - Synoptophore
  - Prisms – used to measure reflex **fusional capacity**
  - **Livingstone gauge**
  - **Pencil test**
  - **RAF ruler (Royal Air Force)**

It can be used to evaluate vergence by measuring

NPC
(Near point of convergence)
The nearest point of binocular fixation

NPA
(Near point of accomodation)
The nearest point of clear focus

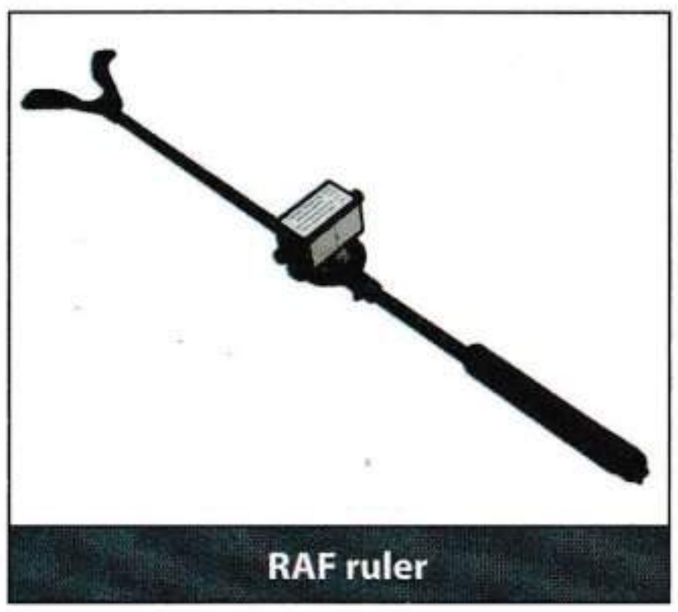
A linear target is moved along the ruler toward the patient

Point at which patient reports **DIPLOPIA**

Ⓝ NPC < 10 cm

Point at which patient reports **BLURRING**

Ⓝ NPA changes with age
20 years – 8 cm
50 years – 46 cm



RAF ruler

V. Measurement of Ocular Deviation

Objective Tests	Subjective Tests	
• Hirschberg's test • Bruckner's test • Krimsky test • Cover-Uncover test • Prism bar cover test	(Based on Diplopia principle) • Maddox rod • Maddox wing • Tangent screen	(Based on Haploscopic principle) • Lancaster R-G test • Synoptophore

Objective Tests

Hirschberg's Corneal Reflex (Reflection) Test

Uses

- Measurement of degree of deviation
- Diagnose direction of deviation
- Helpful to detect pseudostrabismus

Method

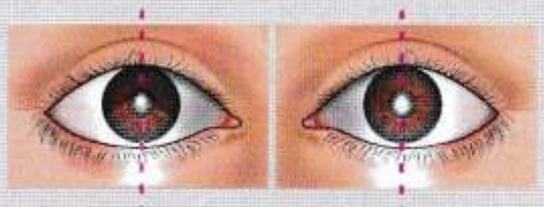
Point source of light is shone into eyes

Patient asked to fixate at light source

Position of corneal reflection (CR) of light is noted in both eyes

NORMAL
CR is seen in the center (slightly nasal) of pupil

RE LE



EXODEVIATION
CR is seen **Nasal** to center of pupil

RE LE

Eye moves out→ CR shines at the same position → appears to be nasal to center

ESODEVIATION
CR is seen **temporal** to center of pupil

RE LE

Mnemonic

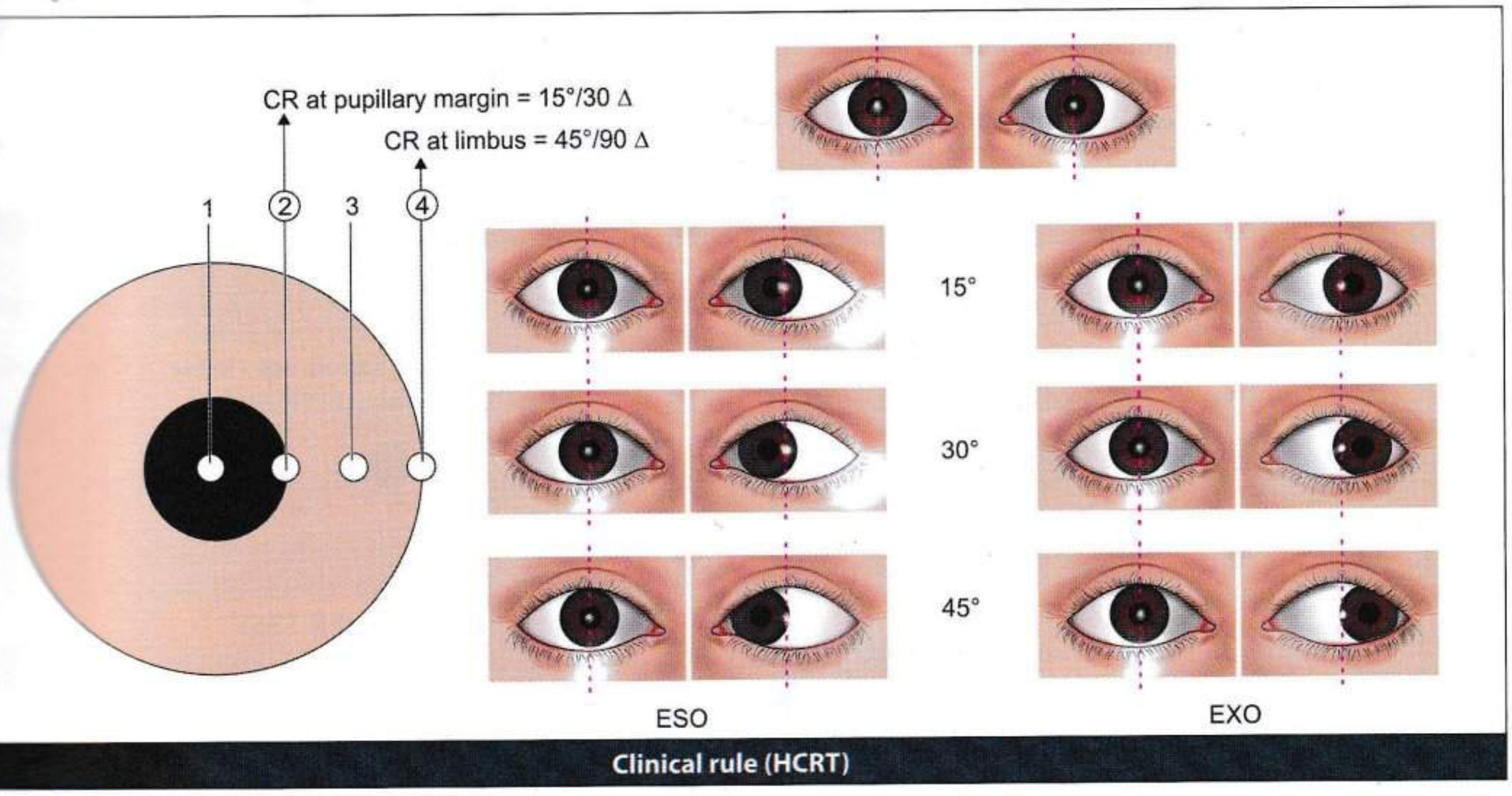
DOOR – **D**eviation **O**pposite **O**f **R**eflex (CR)

Measurement

The position of CR can be measured and quantified to find out the angle of deviation.

1 mm deviation of CR = **7°** deviation = **14 prism dioptre** (Δ) deviation

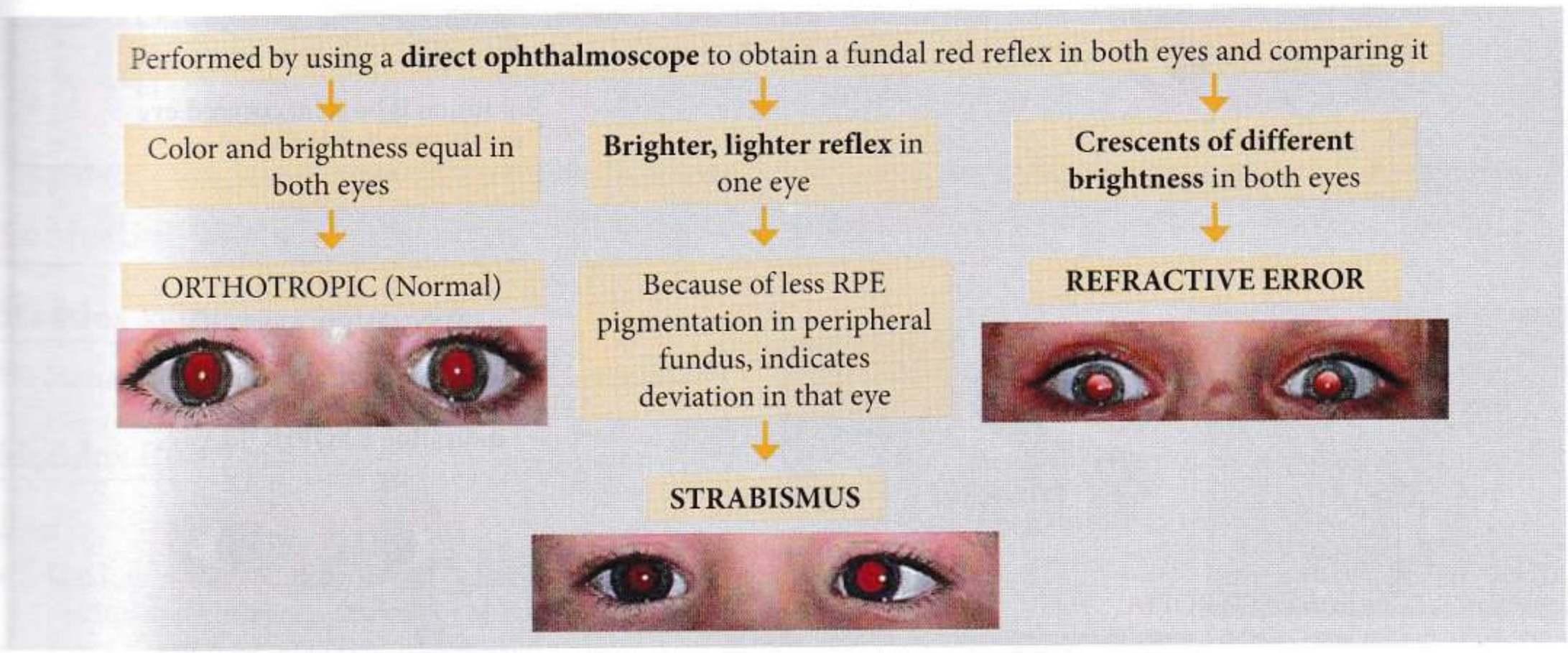
Clinically, this is **not feasible, so**



Clinical rule (HCRT)

Bruckner's Test

- Used to **screen** strabismus and amblyopia **in infants**
- **Method:**


Performed by using a direct ophthalmoscope to obtain a fundal red reflex in both eyes and comparing it
Color and brightness equal in both eyes
ORTHOTROPIC (Normal)
Brighter, lighter reflex in one eye
Because of less RPE pigmentation in peripheral fundus, indicates deviation in that eye
STRABISMUS
Crescents of different brightness in both eyes
REFRACTIVE ERROR

Krimsky Test

Done by placement of **prisms** in front of **nondeviating eye**.

Cover-uncover Test

- **Gold standard** objective method
- **Uses**
  - **Differentiate between Tropia and Phoria**[Q]
  - Differentiate a comitant from incomitant squint
  - Detect pseudostrabismus
- Done for both near (33 cm) and far (6 m) distance
- **Consists** of 3 parts (chronological order of test)
  - **Cover test**[Q] – confirm Tropia
  - **Uncover test**[Q] – diagnose Phoria
  - **Alternate cover test** – measures total (Tropic + Phoric) deviation
- **Method**

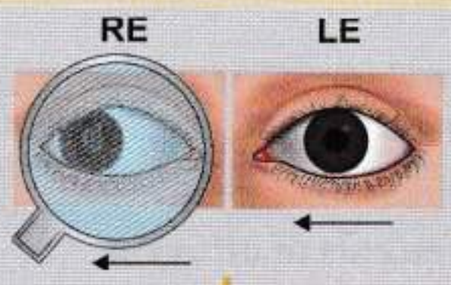
Ask patient to fixate on target and look for presence or absence of deviation

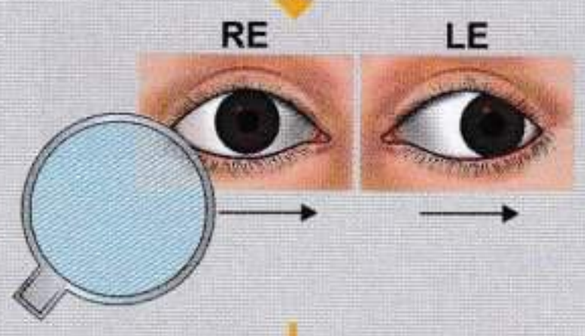
If **deviation visible**

(LE) Exotropia

COVER TEST
Cover the fixating (nondeviating (RE)) eye with occluder

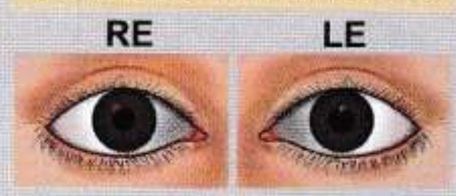
Deviated (non-occluded) (LE) eye moves inwards to pickup fixation (RE) (occluded eye) also moves under cover due to Hering's law





Confirm EXOTROPIA

If **deviation not visible**



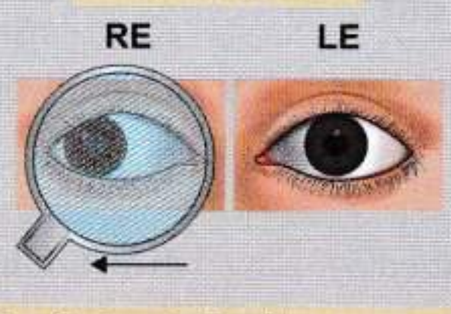
COVER TEST

No movement of uncovered eye
(as uncovered eye is already fixated on object)

No movement

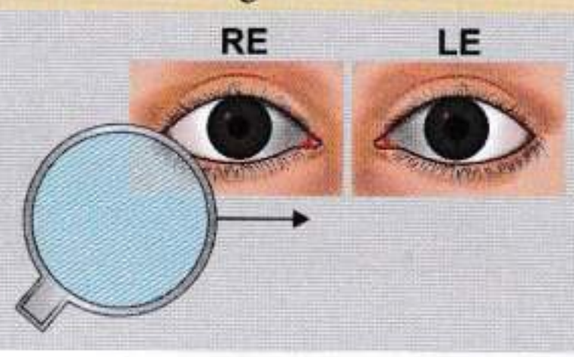
Pseudosquint or Amblyopia or Restrictive squint or Eccentric fixation

No Tropia



But fusion is broken, **covered eye** moves into its position of least resistance

UNCOVER TEST
On uncovering, the (RE) previously covered eye is seen to move inward → indicating EXOPHORIA



Mnemonic

DOOM – **D**irection (deviation) **O**pposite **O**f **M**ovement (of eyes)
CUT – **C**over test
Uncovered eye movement seen
Tropia confirmed
UCP – **U**ncover test
Covered eye movement seen on uncovering
Phoria diagnosed
e.g. If on (RE) **U**ncover test, (RE) moves **in** → (RE) EXOPHORIA
If on (RE) **C**over test, (LE) moves **in** → (LE) EXOTROPIA

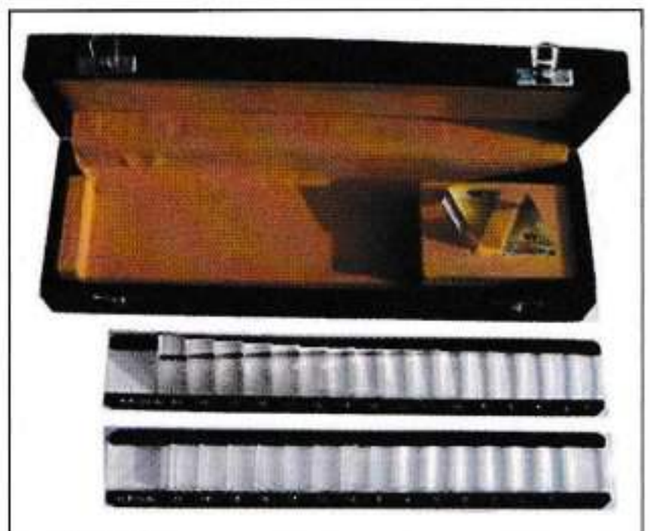
Prism Bar Cover Test (PBCT)

- Best test[Q] for measurement of degree of deviation in Tropia

Method

Prisms (of increasing power) are placed **infront of the deviating eye**

Esotropia – Base Out (BO) Prisms
Exotropia – Base In (BI) Prisms
↓
Examiner performs alternate cover test while holding prism in front of deviated eye
↓
Endpoint – **Neutralization** of misalignment
↓
Quantify prism power (Δ of squint)



Prism bar

Mnemonic

DOOB – **D**eviation
Opposite
of
Base of prism

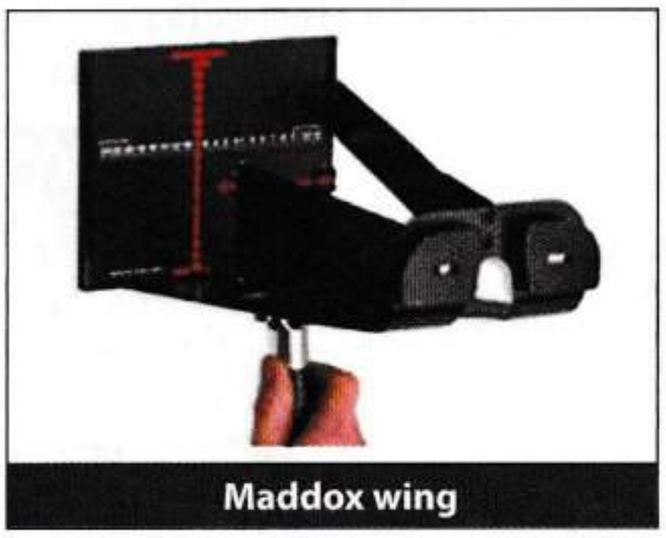
Eso – Base out (BO)
Exo – Base In (BI)

Hyper – Base down (BD)
Hypo – Base up (BU)

Subjective Tests

Maddox Wing

Used to measure **amount of heterophoria in near fixation**[Q]



Maddox wing

Maddox Rod Test

Uses

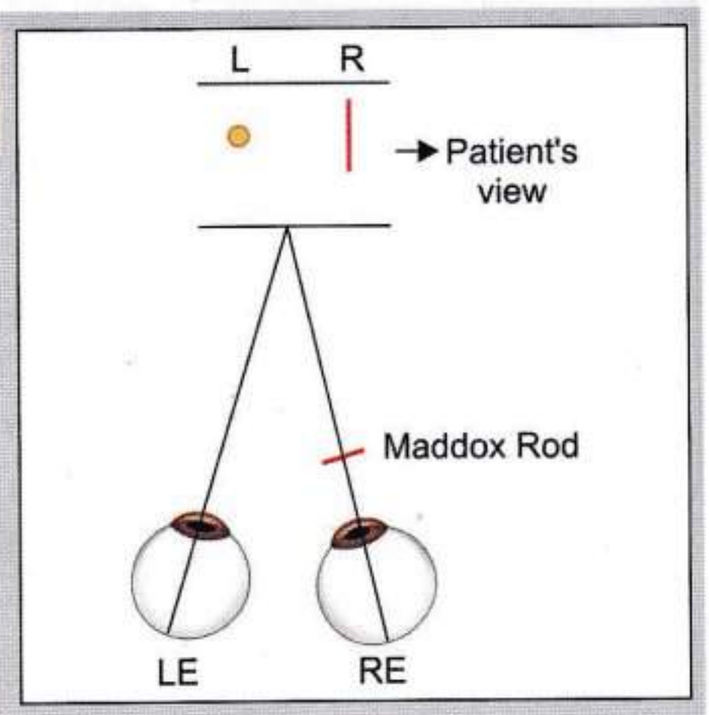
- Used to measure **amount of heterophoria** (both vertical and horizontal deviation) **at far fixation**
- Macular function test
- Double Maddox Rod – for diagnosis of cyclotropia[Q]

Maddox rod

Red parallel PLANO-CONVEX cylindrical lens, which converts point source of light into streak of light

Method

Maddox rod is placed with axes horizontal (produces vertical streak) for horizontal deviation and vertical (produces horizontal streak) for vertical deviation



↓

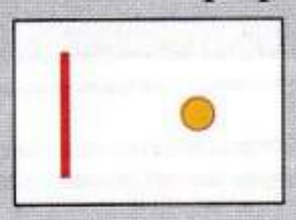
Patient sees one white **spot of light (left eye)** and one **red streak (right eye)**

↓

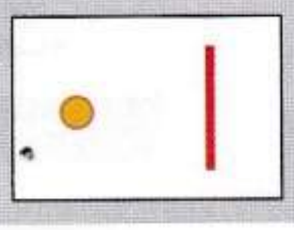
Ask patient the **position of streak relative to spot of light**

↓

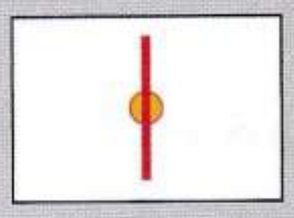
If streak to left of light → (RE) EXOPHORIA (as crossed diplopia)



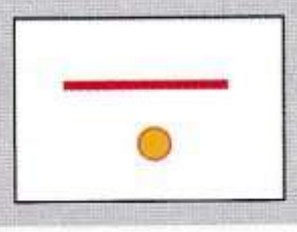
If streak to right of light → (RE) ESOPHORIA



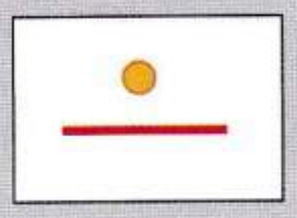
If streak overlaps → ORTHOPHORIA



If streak above → (RE) HYPOPHORIA



If streak below → (RE) HYPERPHORIA



Mnemonic

DOORS – **D**irection (of deviation) **O**pposite **O**f **R**ed **S**treak

HIGH YIELD

Deviation is opposite of test findings

Hirschberg	–	DOOR	– to corneal reflex	PBCT	–	DOOB	– to base of prism
Cover-uncover	–	DOOM	– to movement of eye	Maddox Rod	–	DOORS	– to red streak

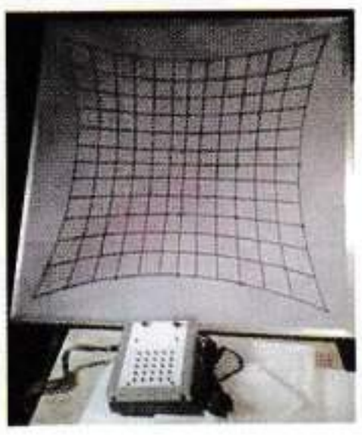
VI. Diplopia – Investigations

These diplopia tests are helpful **in charting Incomitance.**

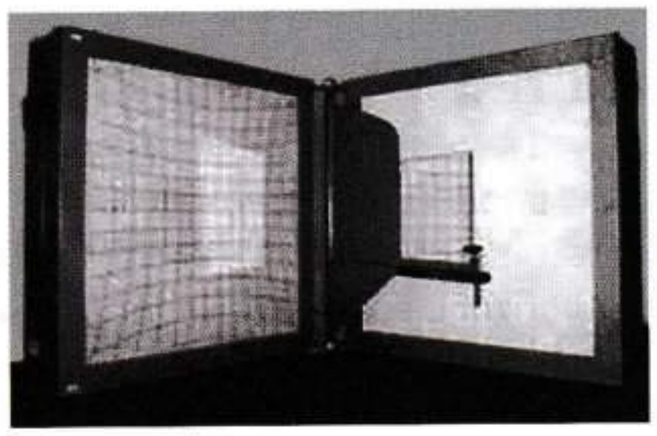
- **Red-green goggles**

  Red over **R**ight eye
  Green over Left eye
  ↓
  Disassociates the 2 images

- **Hess screen**



- **Lees screen**

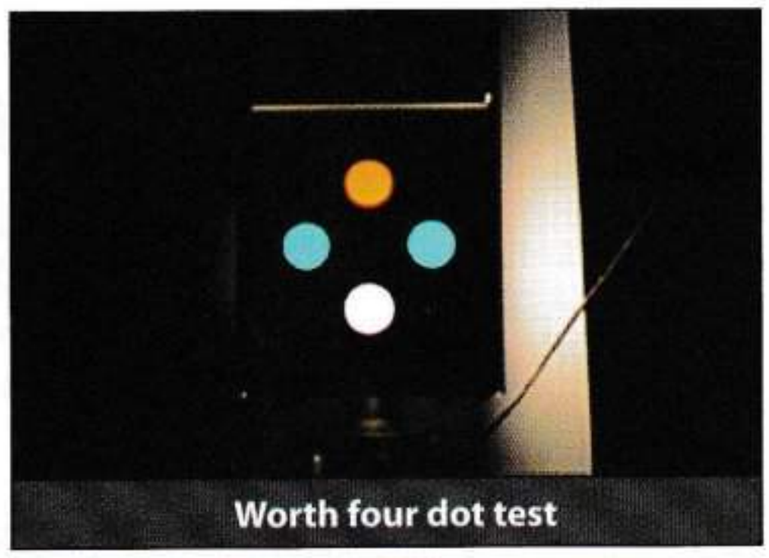


VII. Tests for Sensory Anomalies

- These tests differentiate between
  - Binocular Single Vision (BSV)

- Anomalous Retinal Correspondence (ARC)
- Suppression

Thus, **help in the Prognosis of case of squint.**


Worth four dot test

Worth Four Dot Test[Q]

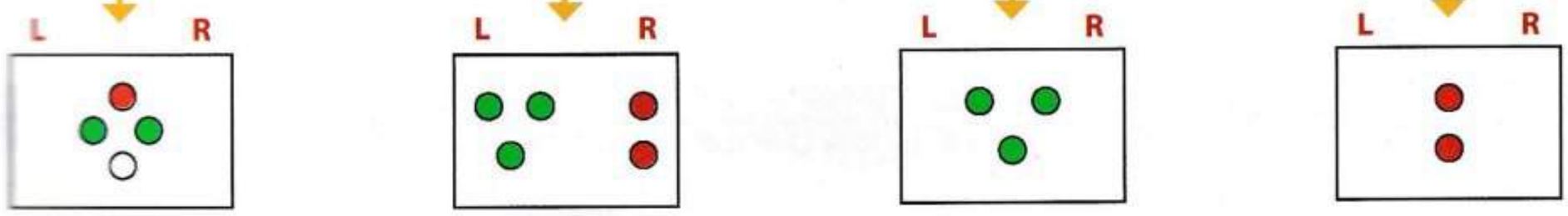
- It is a disassociation test
- Method:

Red-Green goggles are worn by patient (Red over Right) to view four dots **(2 green, 1 red, 1 white)**[Q] on a screen

↓

Ask patient what is seen

↓



Patient has
- BSV
- Harmonious ARC with manifest deviation

Diplopia

Right Eye Suppression

Left Eye Suppression

Bagolini Striated Glasses

- It is the most physiological, least dissociating test
- **Method:**

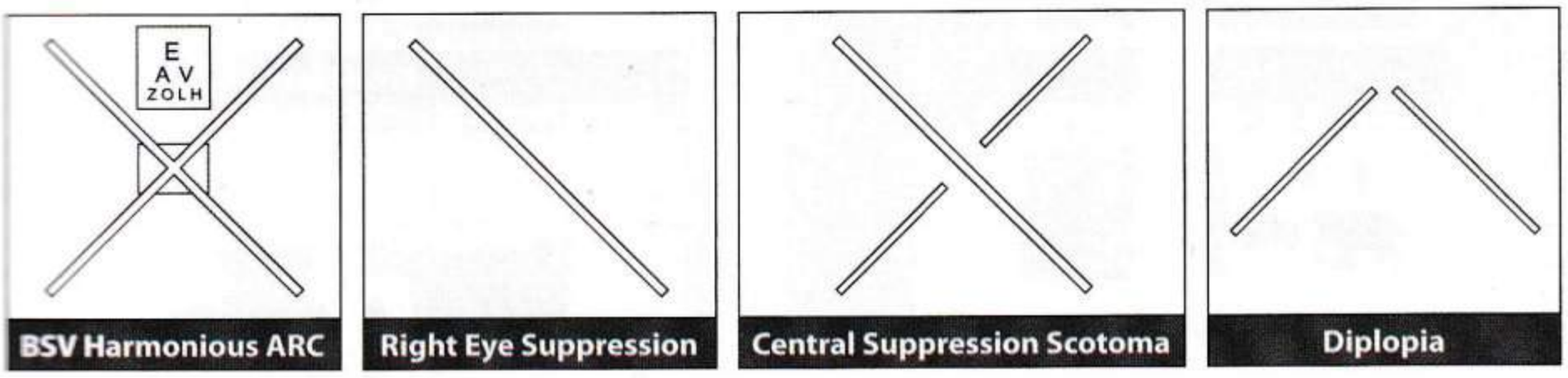
The two **lenses are placed at 45° and 135°** in front of each eye

↓

Each eye will perceive an **oblique streak** of light perpendicular to axis of striations

↓

Finely striated clear lenses



BSV Harmonious ARC

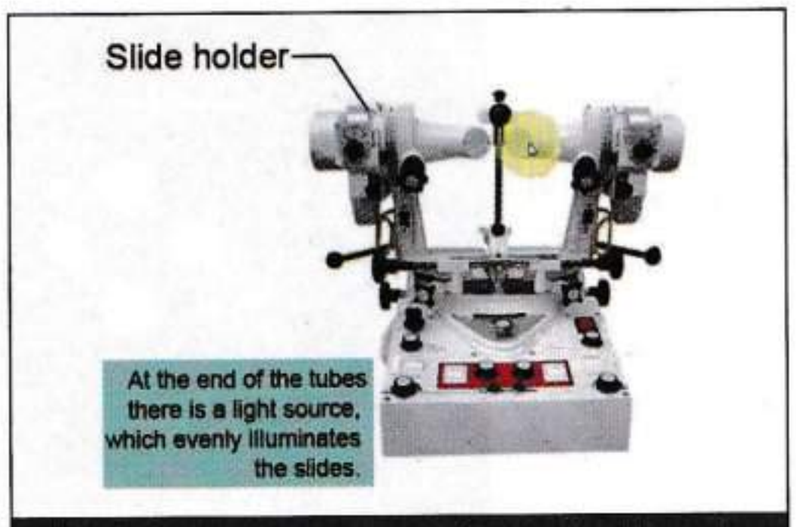
Right Eye Suppression

Central Suppression Scotoma

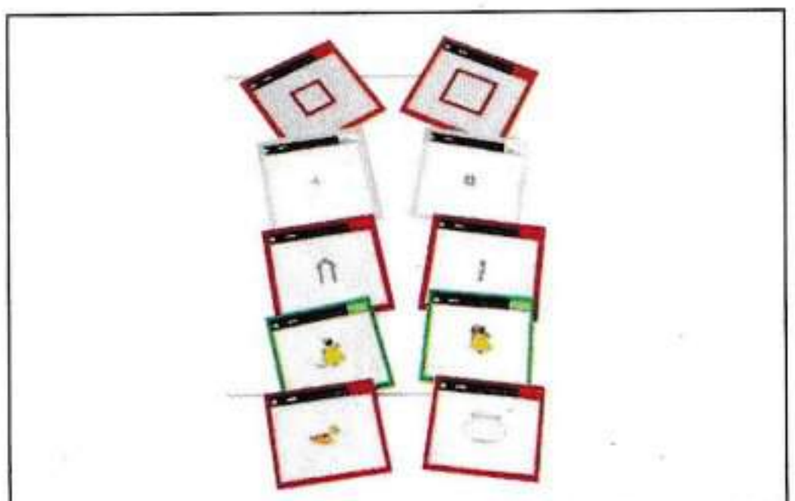
Diplopia

Synoptophore[Q]

- Based an haploscopic principle
- Uses:
  - To measure deviation – torsional
  - Study accommodation convergence
  - Orthoptic exercises
  - Detection of BSV/ARC/Suppression
  - Appreciation of entoptic phenomenon
  - Test for stereopsis



Synoptophore



Synoptophore slides

4Δ Prism Test

- It differentiates between BSV and central suppression scotoma **in microtropia** (Microtropia = <5PD deviation)

After Image Test

- Most dissociating/least physiological test

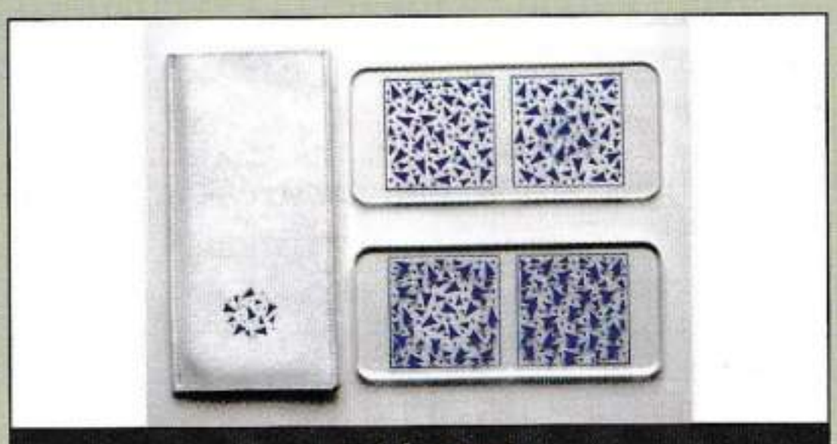
EXTRA MILE

VIII. Tests for stereopsis

- The two pencil test - for gross stereopsis
- Synoptophore
- **Titmus fly stereo test** uses 3D polaroid vectographic pictures
- **Random Dot Stereogram Test**
  - It eliminates use of mono-ocular clues to depth perception
  - Better test than titmus fly
  - Examples are as follows (see the images)

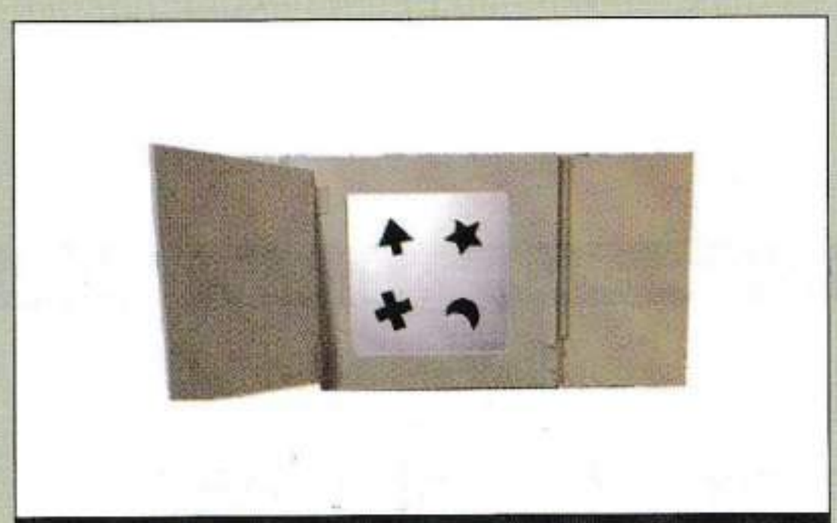
Titmus fly stereo test

TNO test



Frisby test

Lang test



Frisby Davis distance (FD2) Test

EXTRA MILE

Depth Perception

During Binocular vision	During mono-ocular vision[Q]

• Stereopsis[Q]
• Retinal disparity
  • Binasal disparity – remoteness (for) perceived
  • Bitemporal disparity – nearness perceived
	• Motion Parallax (objects moving fast are perceived clear)
	• Overlay of contours
	• Linear perspective
	• Change in apparent size (Larger objects appear nearer)
	• Aerial perspective
	• Shadows and highlights
	• Looming

TYPES OF STRABISMUS

(Please refer to flowchart at the beginning once again)

PSEUDOSTRABISMUS

The eyes **appear to be deviated**, even though the visual axes are aligned with each other, i.e. **eyes are Orthotropic**

Pseudoesotropia (Apparent Convergent Squint)

- Most common type of pseudostrabismus
- Causes:
  - **Negative angle kappa:** (Normal Angle kappa is +5°) if the fovea is situated nasal to the posterior pole, as in
    - High myopia
    - Ectopic fovea
  - **Telecanthus**[Q]: Congenital eyelid malformation where a wide nasal bridge covers the nasal bulbar conjunctiva

Mnemonic

S – PseudeSotropia
T – Telecanthus
E – Epicanthus
M – Myopia

Normal interpupillary distance (IPD) with Increased intercanthal distance (ICD)[Q]

  - **Epicanthus**[Q]: Congenital, bilateral, vertical fold of skin extending from the eyelid (upper or lower) over the medial canthus of eye (See IBQ 32)
  - **Eury blepharon**: Congenital, horizontal elongated palpebral fissure, due to sagging of the lateral aspect of lower eyelid away from the eye
  - Narrow IPD.[Q]

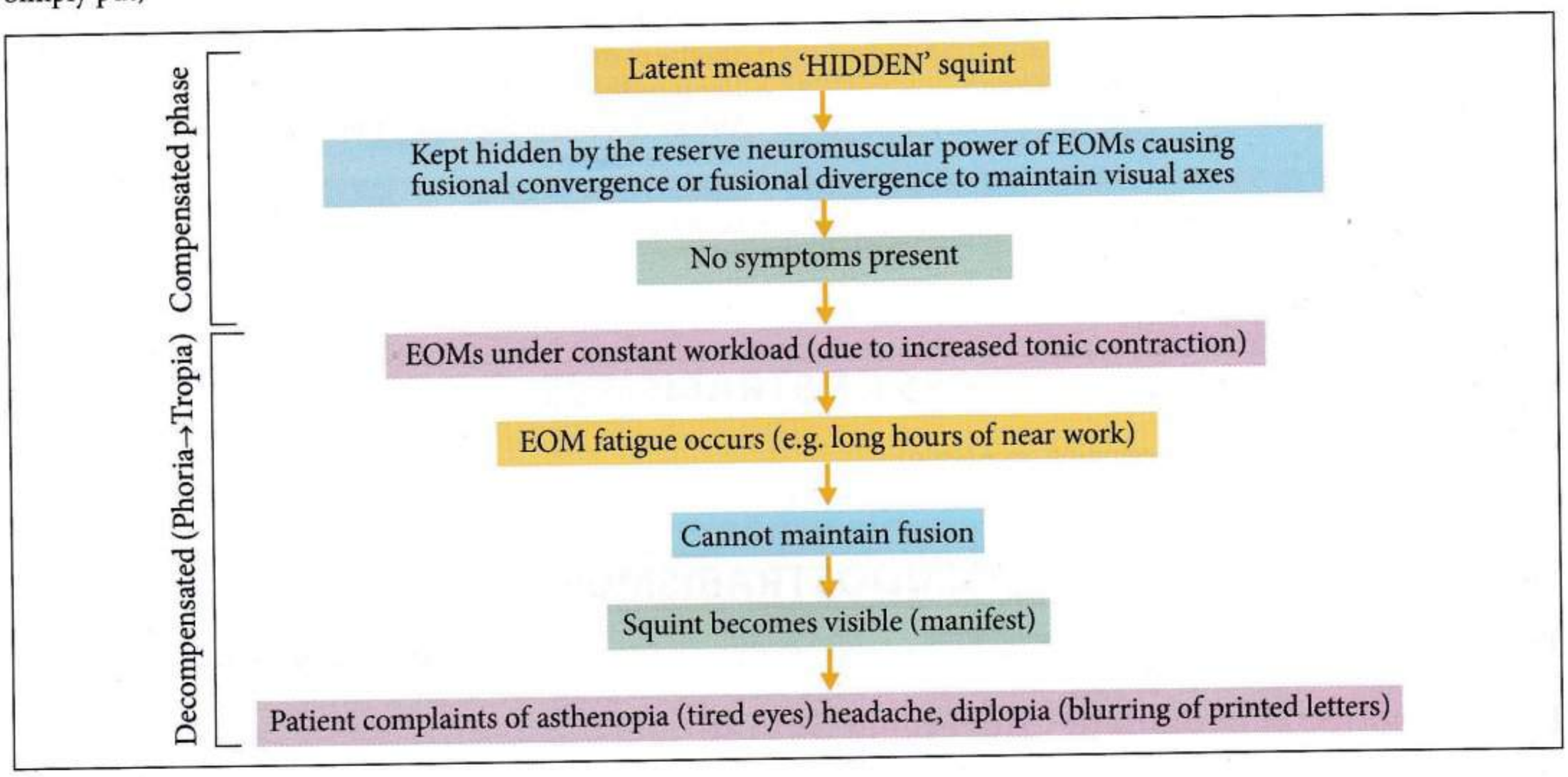
Pseudoexotropia (Apparent Divergent Squint)

- Causes:
  - **Positive Angle Kappa** [>(+)5°]
    - **Retinopathy of prematurity**[Q]- due to temporal displacement of macula
    - Hypermetropia
    - Toxocora retinal scars
  - **Hypertelorism**: Increased IPD with increased ICD[Q]
  - Lateral canthoplasty
  - Wide IPD

HETEROPHORIA (LATENT SQUINT)

A tendency of eyes to undergo deviation/squint only when fusion is broken due to insufficient fusional vergence.

Simply put,


Compensated phase
Decompensated (Phoria→Tropia)
Latent means 'HIDDEN' squint
Kept hidden by the reserve neuromuscular power of EOMs causing fusional convergence or fusional divergence to maintain visual axes
No symptoms present
EOMs under constant workload (due to increased tonic contraction)
EOM fatigue occurs (e.g. long hours of near work)
Cannot maintain fusion
Squint becomes visible (manifest)
Patient complaints of asthenopia (tired eyes) headache, diplopia (blurring of printed letters)

Types of Heterophoria

Esophoria – Convergence Tendency

- Types:
  - Convergence excess– Eso at near > distance
  - Divergence insufficiency–Eso at distance > near
- More common in younger age group with increased near work
- More common in hypermetropia

Mnemonic

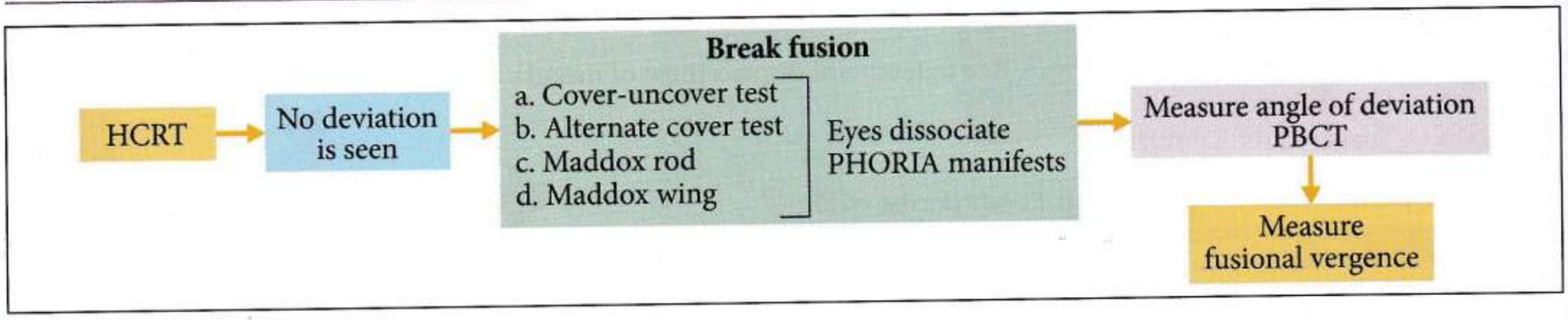
Dr. Utsav is SO/ESO HYPER/Hypermetropia

Exophoria – Divergence Tendency

- Types:
  - Convergence Insufficiency: Exo at near > distance
  - Divergence Excess– Exo at distance > near
- More common in Myopia and presbyopia

This is MC Phoria

Investigations in case of Phoria



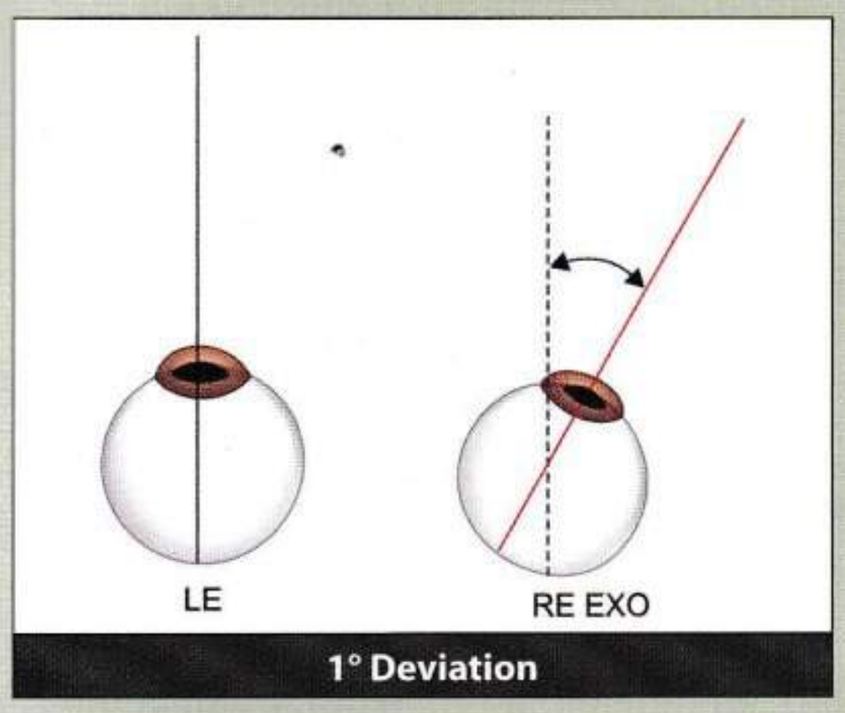
Treatment

- Refractive error assessment and correction
- Fresnel prisms
- Orthoptic exercises
- Surgery

HETEROTROPIA (MANIFEST SQUINT)

	Comitant	Incomitant
Degree of squint	**Same** in all positions of gaze	**Varies** with gaze[Q]
Secondary deviation	**Equal** to primary deviation	**More than Primary deviation**[Q]
Ocular movements	Full	**Restricted** in direction of action of involved muscle
Diplopia	Absent (except DVD) [Q]	**Present**[Q]
Abnormal head posture	Absent	**Present**[Q] (to prevent diplopia)
Sensory adaptations (ARC and Suppression)	**Frequent**	Rare
Onset	Early childhood[Q]	Late age[Q] (usually)

EXTRA MILE



1° Deviation

1° Deviation
Measurement of angle of deviation with the normal (left) eye fixating

↓

For (Right) Deviating eye to move inward and fixate at object, RMR receives innervation, thus its yoke muscle LLR will also receive innervation **(Hering's law)**

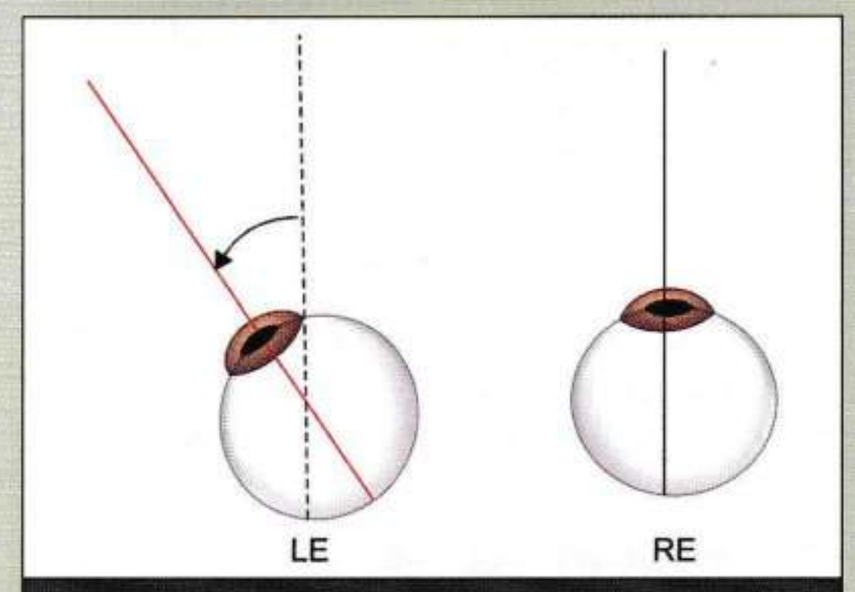
↓

Right eye fixates, left eye in response move out due to LLR function

↓

Measurement of deviation with deviating (Right) eye fixating

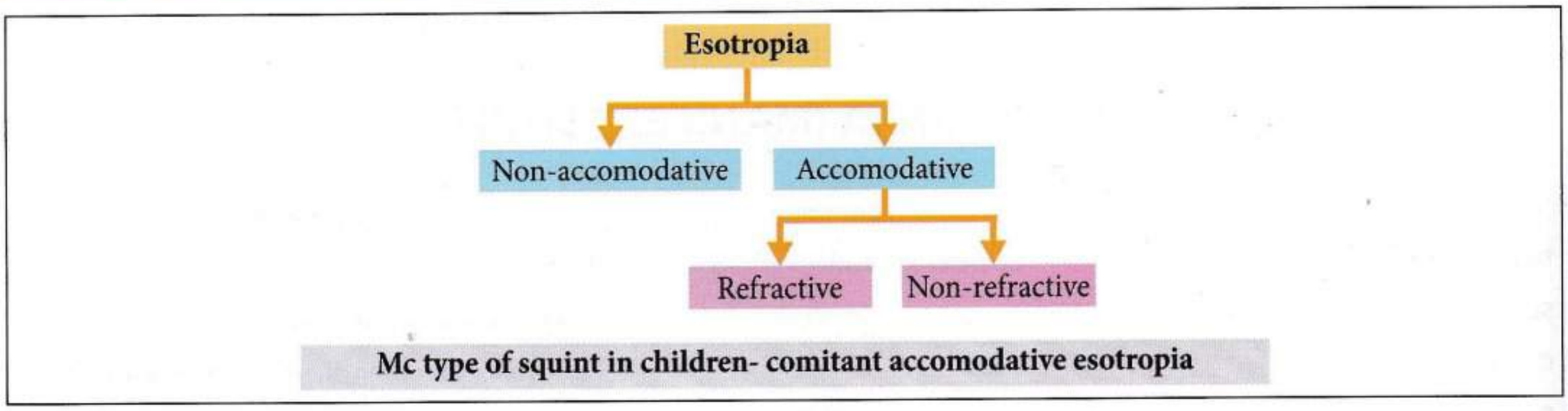
2° deviation



2° Deviation

COMITANT SQUINT

Esotropia (Convergent Squint)



Mc type of squint in children- comitant accomodative esotropia

Non-accommodative Esotropia

Essential infantile esotropia (MC Type of Congenital Esotropia)

- Present by 4–6 months of age[Q]
- **Large angle esodeviation (> 30 pd)**
- BSV does not develop and amblyopia may be seen
- **Associated with**[Q]
  - Latent horizontal nystagmus
  - Inferior oblique overaction
  - Asymmetric OKN
- No refractory error
- Alternate fixation in primary gaze or cross fixation
- Dissociated vertical deviation[Q] (DVD) – 80% cases
- **Treatment**
  - **Prevent amblyopia** by occlusion therapy
  - Early surgery is advocated – **T/t of choice**[Q] (by 12 months of age)
    - **MR recession** (3 to 5 mm)[Q] – (to loosen – lengthening of muscle–weakening procedure)
      LR resection (5 to 8 mm)[Q] – (to cut–shortening of muscle–strengthening procedure)
    - Bimedial recession (3 to 5 mm)
  - Botulinum Toxin A into medial rectus – chemodenervation – temporary paralysis

Accomodative Esotropia (2–3 years of age)[Q]

Refractive	Non-refractive
• Normal AC/A ratio (accommodative convergence/ accommodation	• High AC/A ratio
• Due to **hypermetropia**[Q] from +2 to +7D as ↑ accommodative effort needed to clearly focus at near work (↑A) ↓ ↑ convergence occurs along as part of near reflex (↑AC)	• Due to either increased convergence or decreased accommodation
• Esotropia at distance ≥ near	• Esotropia at distance < near
Treatment • **Spectacles**[Q] – full cycloplegic correction Unifocal convex spectacles • Orthoptic exercises • Surgery ▪ Recession and resection ▪ Bimedial recession	**Treatment** • Spectacles[Q] – full cycloplegic correction Bifocals with near add • Surgery ▪ Bimedial recession-choice[Q] ▪ **FADEN**[Q] (retro equatorial myoexy) • **Miotics**[Q] – Such as echothiophate, DEP may be used as they reduce AC/A ratio

Exotropia (Divergent Squint)

- It is most commonly intermittent
- Treatment
  - Orthoptic exercises
    - Anti-suppression
    - Convergence
  - Surgery – LR Recession (5–7 mm) with MR resection (4–8 mm)
- Presents with asthenopia and Diplopia Phobia

Hypertropia (Vertical Squint)

- Causes
  - Longstanding IV Cranial nerve (superior oblique) palsy
  - Skew deviation

INCOMITANT SQUINT

Paralytic	Restrictive
Due to motor deficiency (lower motor neuron, nerve, muscles)	Due to mechanical factors such as contracture or fibrosis or muscle entrapment

They can be differentiated by the following tests:

FORCED DUCTION TEST (FDT)

Tests the presence or absence of restriction.

Patient asked to look in the direction of action of muscle being tested

↓

Eye held at limbus with forceps and rotated in the direction of action of muscle

- Eye moves freely → No restriction → FDT-**Negative**[Q] → Paralytic squint
- Eye does not move → Restriction present → **FDT-Positive**[Q] → Restrictive Squint

ACTIVE FORCE GENERATION TEST (AFGT)

Eye held at limbus with forceps

↓

Patient asked to look in direction of action of muscle

- 'TUG' felt → Means patient attempts to move eye → No paralysis → Restrictive squint
- 'TUG' absent → Means patient cant move eye → Paralysis of EOM → Paralytic squint

Paralytic Squint

Clinical Features

- **Diplopia**[Q]– in the direction of action of muscle
- **Limitation of movement** – in the direction of action of muscle
- **Abnormal head posture**[Q]– in the direction of action of muscle
- **Deviation of eye**– in the direction opposite to action of muscle
- Secondary deviation> Primary deviation[Q]
- False projection or orientation
- Confusion[Q]
- Vertigo[Q]

Paralysis can be of any of the 3 cranial nerves supplying the EOM. $SO_4\ LR_6\ O_3$

Oculomotor/Third Cranial Nerve Palsy

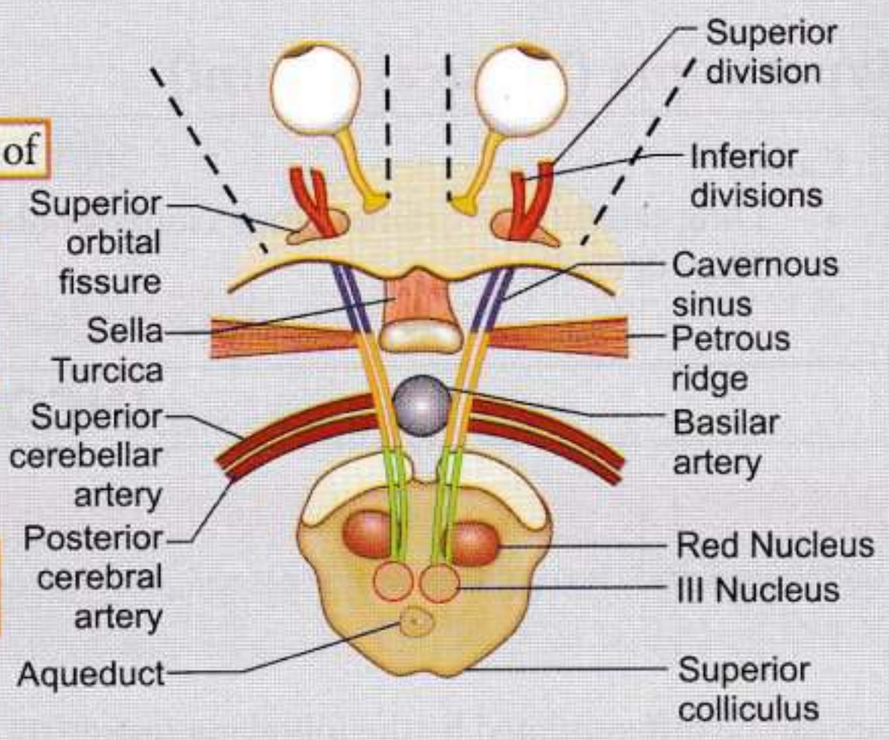
Correlate Box

Course

NUCLEAR COMPLEX

Situated in mid-brain at level of superior colliculus[Q], composed of

- **MAIN MOTOR nucleus**
  - 2 paired subnuclei
    - Innervates C/L-SR[Q]
    - Innervates I/L-MR, IR, IO
  - 1 unpaired subnuclei
    - Innervates both LPS[Q]
- **EDINGER-WESTPHAL nucleus-sends preganglionic parasymphathetic fibers[Q]**
  - Supplies sphincter pupillae and ciliary muscle



FASCICULAR
Fibers pass through red nucleus[Q] into interpendecular

BASILAR
Leaves the mid-brain on the medial aspect of the cerebral peduncle
Passes between posterior cerebral artery and superior cerebellar artery

INTRACAVERNOUS
Runs in the **lateral wall**[Q] above trochlear nerve
divides into superior and inferior branches and enter orbit through superior orbital fissure[Q] **within annulus of zinn**[Q]

INTRAORBITAL
Superior division supplies → LPS and SR
Inferior division supplies → IR, IO and MR

Clinical Features[Q]

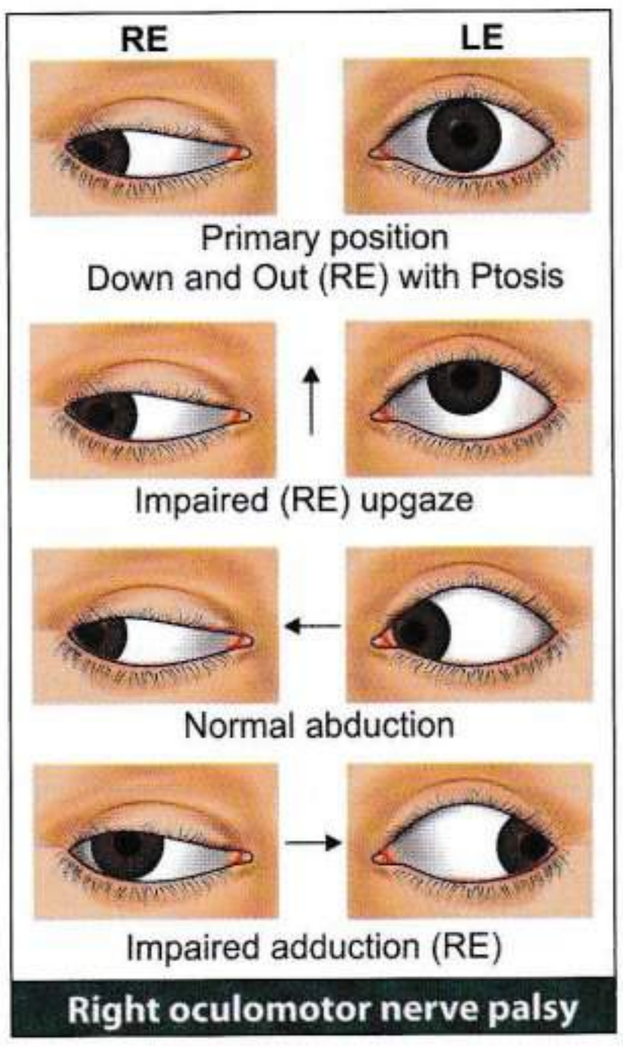
- **Ipsilateral ptosis**[Q] – due to LPS palsy (prevents diplopia, as it covers paralytic eye)
- Position of Eyeball

Down → Due to unopposed action of SO, as both elevators (IO & SR) are paralyzed

&

Out[Q] → Due to unopposed action of LR, as all ADductors (MR, SR & IR) are paralyzed

- **Mydriasis**–due to palsy of sphincter pupillae[Q] [Loss of light reflex]
- Defect in accomodation[Q]–due to ciliary muscle paralysis [Loss of accomodation/near reflex]



Right oculomotor nerve palsy

- **Crossed Diplopia**– due to eye being out (Exotropia)

eXo- 'X' indicates cross—thus, Crossed diplopia

HIGH YIELD

Special causes and clinical features

- **Nuclear 3rd CN Palsy**
  - Bilateral ptosis (due to unpaired nuclei for LPS)
  - Bilateral mydriasis and cycloplegia
  - Contralateral SR weakness
- Ipsilateral Oculomotor Nerve Palsy

with contralateral extrapyramidal signs (flapping tremors)	with contralateral hemiparesis	with cerebellar ataxia
↓	↓	↓
Benedikt syndrome (Lesion through red nucleus)	**Weber syndrome** (Lesion through cerebral peduncle)	**Nothangel syndrome**

- **Isolated oculomotor nerve palsy with pupillary sparing**
  - Diabetes mellitus– MC[Q]- **Painful**
  - Hypertension
  - Atherosclerosis

  (Refer Q73)
- **Isolated pupillary palsy**– only mydriasis seen
  - Uncal herniation[Q]
  - Diphtheria
  - Basal meningitis
  - Botulism
- **Trauma**– Pupil is miosed due to irritation
- Isolated oculomotor nerve palsy, painful with pupillary involvement– **Posterior communicating artery (intracranial) aneurysm**

Treatment

- Observation– for at least 6 months, as the 3rd cranial nerve **can regenerate**
- Surgery

Aberrant Regeneration of Nerve Fibers

Pseudo-von Graefe Sign	Pseudo-Argyll Robertson Pupil (Pseudo ARP)	Horizontal Gaze Lid Dyskinesis
Fibers of IR misdirected to LPS ↓ On downgaze, upper eyelid retracts thus, instead of following eyeball movement and going down, eyelid instead moves up ↓ Gives appearance of lid lag	Fibers of ciliary muscle are misdirected to sphincter pupillae and fibers of sphincter pupillae damaged ↓ On accommodation, pupil also constricts (Accommodation reflex present) but on light exposure, pupil doesnot constrict (light reflex absent)	Fibers of MR are misdirected to LPS ↓ Upper eyelid retracts on Adduction & falls on ABduction

Trochlear/Fourth Cranial Nerve Palsy/Superior Oblique Palsy

- **MC congenital** paralytic squint

Correlate Box

Course

Nucleus
Midbrain at the level of inferior colliculus

↓

Fascicular
Curves around aqueduct of sylvius and decussates

↓

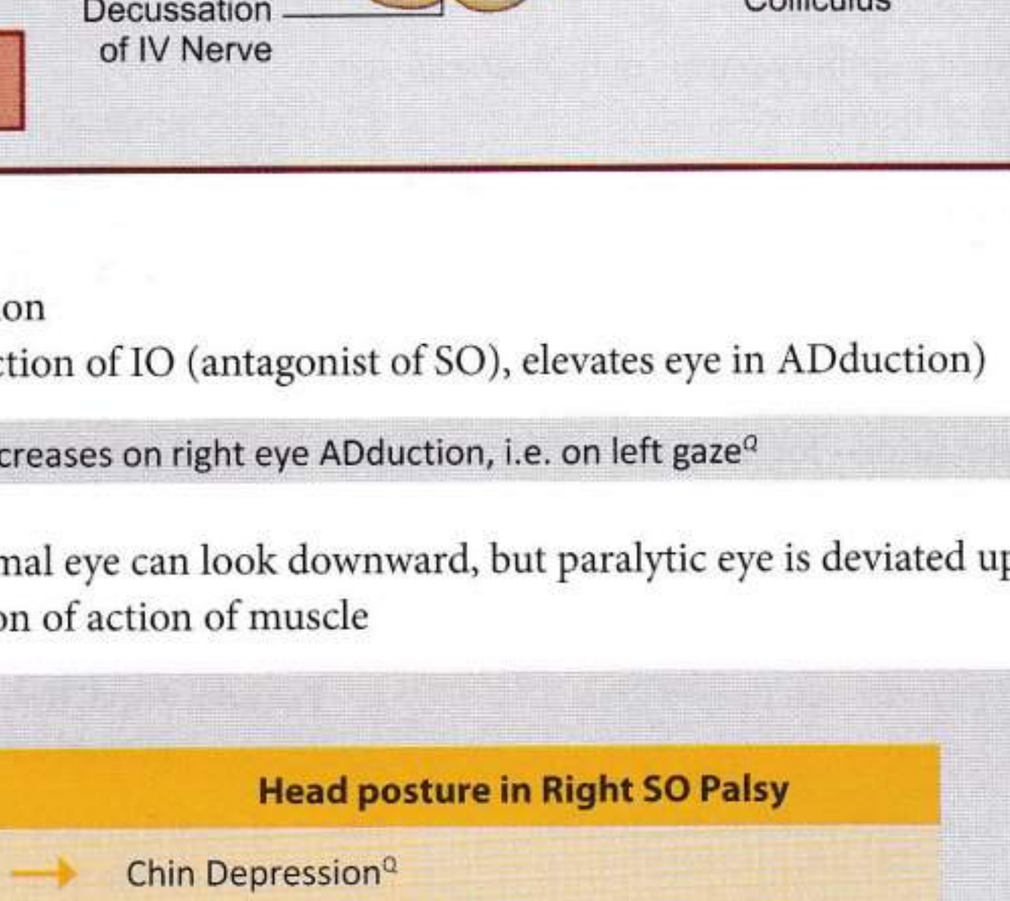
Trunk
Leaves the midbrain **on the dorsal surface**[Q] passes between posterior cerebral and superior cerebellar arteries

↓

Cavernous
Runs in the **lateral wall** between oculomotor nerve and ophthalmic (branch of trigeminal) nerve
Passes into orbit through superior orbital fissure[Q] **outside**[Q] **the annulus of zinn**

↓

Intraorbital
Innervates **contralateral**[Q] **superior oblique**



Clinical Features

- **Ipsilateral Hypertropia**[Q] – due to limitation of depression
- **Increase in hypertropia on ADduction** – due to overaction of IO (antagonist of SO), elevates eye in ADduction)

Right SO palsy– Right hypertropia increases on right eye ADduction, i.e. on left gaze[Q]

- **Vertical Diplopia** – While coming downstairs[Q] (as normal eye can look downward, but paralytic eye is deviated upwards)
- **Abnormal Head Posture**[Q] – Head Moves in the direction of action of muscle

e.g. Right SO palsy

Functions of Right SO		Head posture in Right SO Palsy
• Depression in ADduction i.e. depression in left gaze	→	Chin Depression[Q] Face Turn Toward Left[Q] (opposite side)
• Intorsion i.e. right eye rotates inward (left side)	→	Head Tilt Toward Left[Q] (Opposite side)

- Indicators of Bilateral SO Palsy
  - If following head trauma
  - If right hypertropia in left gaze and left hypertropia in right gaze
  - Double Maddox rod test shows >10° cyclodeviation
  - V pattern esotropia

Specific Tests

- **Park's 3 step test**

Step 1 – Identify hypertropic eye

(LE) hypertropia

Step 2 – **WOOG**[Q]

Hypertropia gets worse on opposite gaze

(LE) hypertropia ↑ses on right gaze

Step 3 – **BOOT**[Q]

Hypertropia gets better on opposite tilt

(LE) hypertropia ↓ses on right tilt

- **Double Maddox Rod Test**

  Unilateral palsy <10°cyclodeviation

  Bilateral palsy > 10° cyclodeviation

Treatment

- Done according to KNAPP's classification
- MC procedure done is **Inferior oblique weakening**

Abducens/ Sixth Cranial Nerve Palsy/ Lateral Rectus Palsy

- MC acquired[Q] **paralytic squint**, usually following head injury or due to raised ICP

Correlate Box

Course

Nucleus
Situated in **pons**[Q], Ventral to floor of 4th ventricle

↓

Fascicular
leaves brainstem at pontomedullary junction

↓

Basilar
enters basilar cistern and crossed by anterior inferior cerebellar artery
Passes through **dorello canal**[Q] and **enters cavernous sinus**

↓

Intracavernous
Runs **inferomedially in the lateral wall**, in close relation to ICA[Q]

↓

Enter orbit through superior orbirtal fissure **within annulus of ZINN**

↓

Intraorbital
Innervates Ipsilateral lateral rectus

HIGH YIELD

Clinical Features

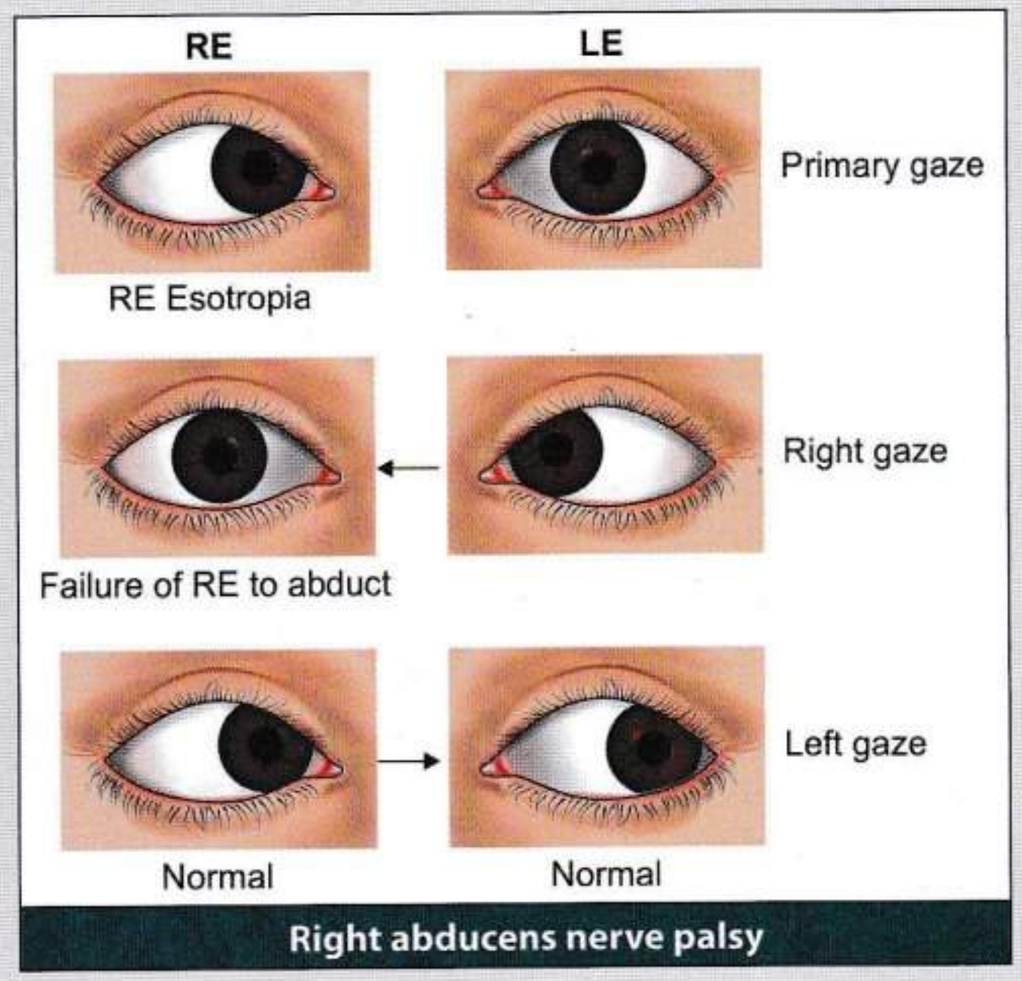
- **Ipsilateral esotropia**[Q] – due to limitation of ABduction

  i.e. right lateral rectus palsy[Q] presents with Right esotropia

- Esotropia is characteristically worse for far distance
- **Abnormal Head posture**[Q]– Face Turn toward same Side[Q]

  e.g. Right LR palsy
  Right eye cannot abduct, i.e. move toward right side
  ↓
  Instead face turns toward right side[Q]

- **Uncrossed diplopia**[Q]– due to eye being ESOTROPIC
- **Ipsilateral horizontal gaze palsy**: Seen in nuclear lesions
- **Ipsilateral facial nerve palsy**: In cases of nuclear 6th nerve palsy, as facial nerve loops around 6th nerve nucleus



Right abducens nerve palsy

Special Causes and Clinical Presentations

- **Foville Syndrome** – Ipsilateral V/VI/VII/VIII cranial nerve palsy (+) central horner's syndrome
- **Millard-Gubler syndrome** – Ipsilateral VI and VII cranial nerve palsy (+) contralateral hemiplegia
- Acoustic neuroma
- **Raised intracranial pressure** – False localizing sign[Q]
- **Mobius syndrome**[Q] – Bilateral VI/VII cranial nerve palsy
- **Gradenigo's syndrome** – V nerve involvement (periorbital pain) (+) VI nerve palsy (+) Otorrhoea (due to otitis media)

Restrictive Squint

Congenital	Acquired
• Duane's Retraction syndrome (DRS) • Brown's superior oblique Sheath syndrome (BSOSS) • Congenital fibrosis of extraocular muscles (CFEOM) • Strabismus Fixus	• Orbital tumors • Orbital Trauma

Duane's Retraction Syndrome

- **It is characterized by**
  - Limitation of ABduction and/or ADduction
  - Narrowing of palpebral fissure on attempted ADduction
  - Retraction of globe and variable upshot/ downshoot of eye on attempted ADduction
- **Types** (Huber) and clinical features

	Limitation of movement	Narrowing of fissure and retraction of globe during attempted movement
I	ABDUCTION	ADDUCTION
II	ADDUCTION	ADDUCTION
III	ABDUCTION & ADDUCTION[Q]	ABDUCTION & ADDUCTION

Mnemonic

BiDi
Demand **D**raft
2 **Bi**D**i**

SOCH

- Cause
  - Type I

Paradoxical innervation of LR

↓

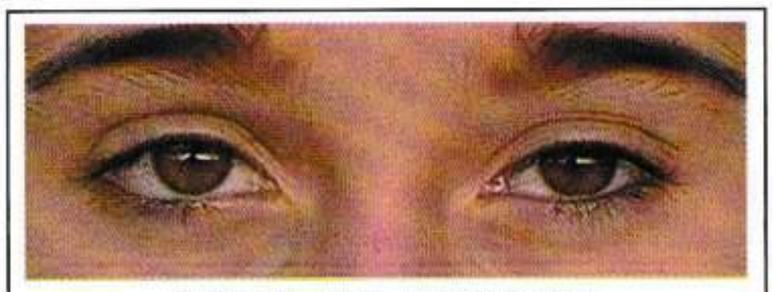
LR gets innervated by fibers of III nerve instead of VI nerve

↓

On impulse for abduction via VI nerve–AB duction limitation

↓

On impulse for Adduction via III nerve both LR and MR contract – thus causing retraction of globe [as the antagonist (LR) instead of relaxation, starts to contract]



Primary gaze–no deviation

Right gaze –narrowing of left palpebral fissure with retraction of globe

Left gaze–limitation of abduction of LE

Type I DRS – LE

  - Type II – Not known
  - Type III – Paradoxical innervation of both LR & MR

Brown's Syndrome

Occurs **due to mechanical restriction** caused by congenitally tight superior oblique sheath or by impaired movement of superior oblique tendon through the trochlea (congenital click syndrome) It may also be acquired in some cases

↓

Contracture of superior oblique **leads to restriction of action of its antagonist – Inferior oblique**

↓

Presents with – Absence of Elevation in ADduction

Congenital Fibrosis of Extraocular Muscles (CFEOM)

- Usually AD
- Presents with
  - Bilateral Ptosis with chin elevation
  - Bilateral hypotropia – (downward fixation) or Limitation of elevation

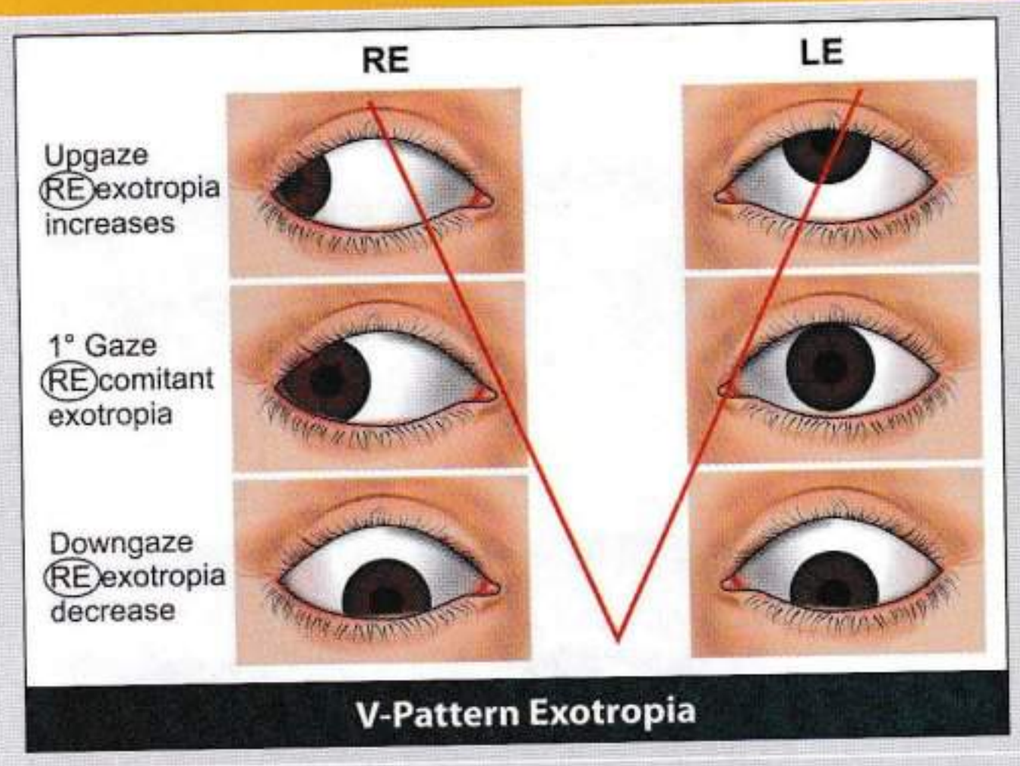
Strabismus Fixus

- Convergent squint–Due to MR fibrosis with LR palsy
- Divergent (rare)

A-V Pattern Squint

Horizontally comitant (degree of deviation doesnot vary in horizontal movements of the eyes) and vertically incomitant deviations (degree of deviation varies in vertical movements of the eyes) – present as A and V pattern

V pattern

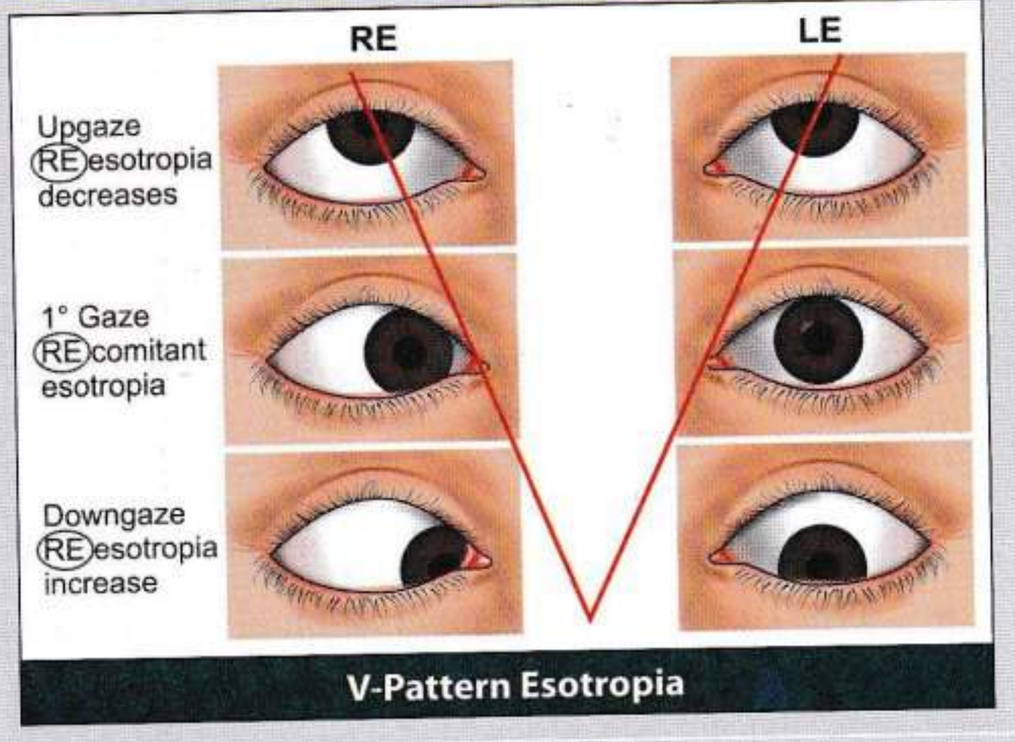


V-Pattern Exotropia

Relative divergence on upgaze (exotropia increases on upgaze)

Cause

- Overaction of Inferior oblique (most common)
- Underaction of superior oblique



V-Pattern Esotropia

Relative convergence on downgaze (esotropia increases on downgaze)

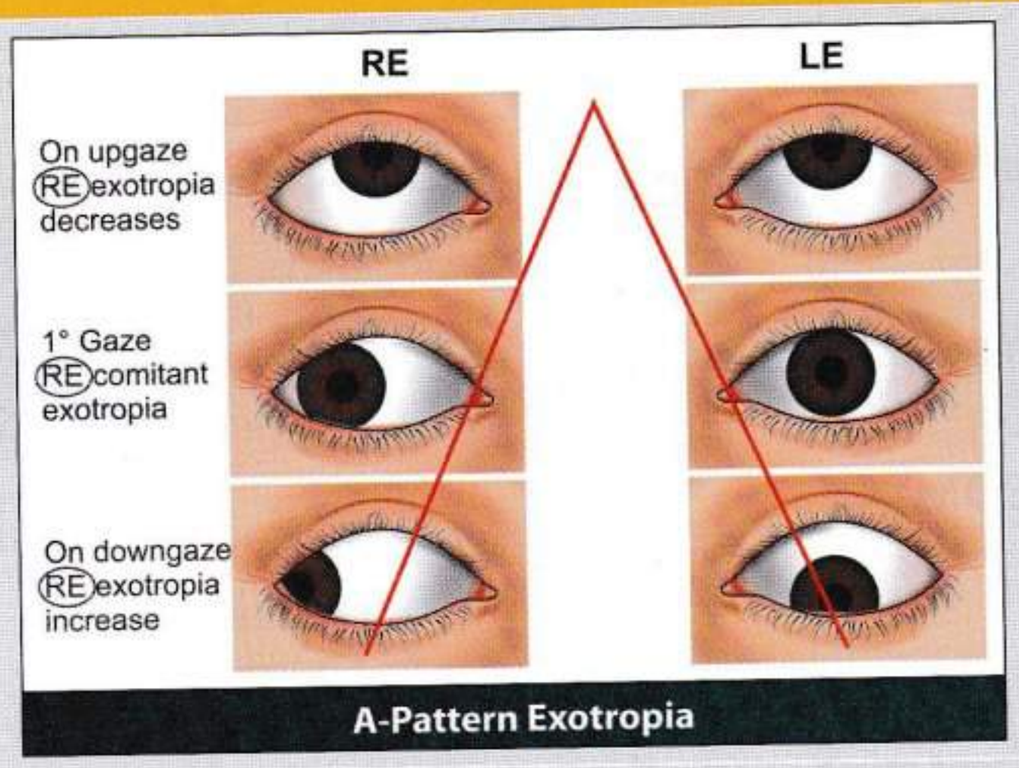
Cause

- Overaction of inferior rectus
- Underaction of superior rectus

Diagnosis

A 15 pd difference between upgaze and downgaze is significant

A pattern

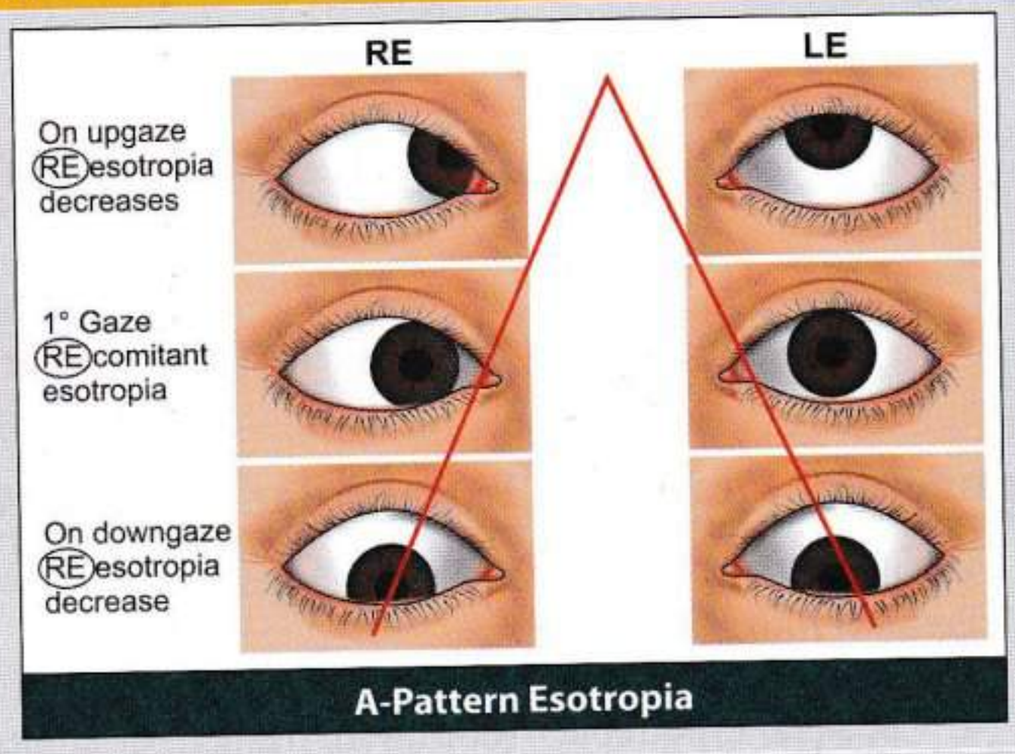


A-Pattern Exotropia

Relative divergence on downgaze (exotropia increases on downgaze)

Cause

- Overaction of superior oblique (most common)
- Underaction of inferior oblique



A-Pattern Esotropia

Relative convergence on upgaze (esotropia increases on upgaze)

Cause

- Overaction of superior rectus
- Underaction of inferior rectus

Diagnosis

A 10 pd difference between upgaze and downgaze is significant

SUPRANUCLEAR CONTROL OF OCULAR MOVEMENTS

What we have discussed till now as part of paralytic squint, concerns only the Lower Motor Neuron control of EOMs

↓

But, what controls the motor nuclei

↓

SUPRANUCLEAR CONTROL OF OCULAR MOVEMENTS
Centre(s) are situated in the cerebral cortex for **control of Voluntary Conjugate movements**

Cerebral cortex

Frontal cortex
Frontal eye field (FEF) and parietal eye field (PEF)

Initiates
Saccades - 'Rapid[Q] Involuntary/Voluntary[Q] fixating, eye movements which place the object of interest on fovea

Horizontal saccades - controlled **contralaterally**

Vertical saccades - controlled by **bilateral** stimulli

Superior colliculus

Brainstem
Contains **centre for Gaze**
Horizontal Gaze - PPRF
Vertical Gaze - ri MLF

Cranial nerve nuclei

Extraocular muscles

Occipital cortex

Initiates
Pursuits - slow, voluntary eye movements for maintaining image of slow moving object on fovea

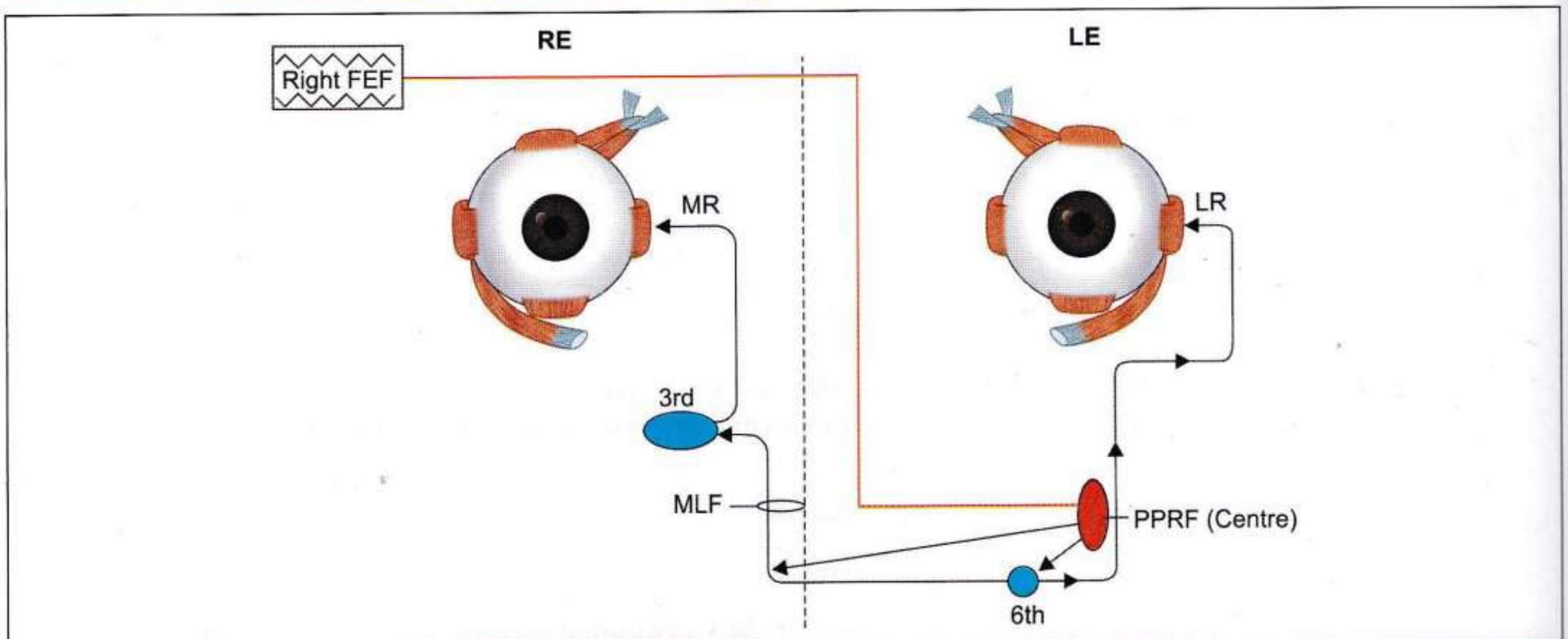
Controlled ipsilaterally

Vestibular apparatus
Controls reflex[Q] conjugate movement

Vestibulo-ocular reflex (VOR)
Slow, movement of eye during head/body movement

Optokinetic reflex
Slow movements generated during movements of visual surroundings

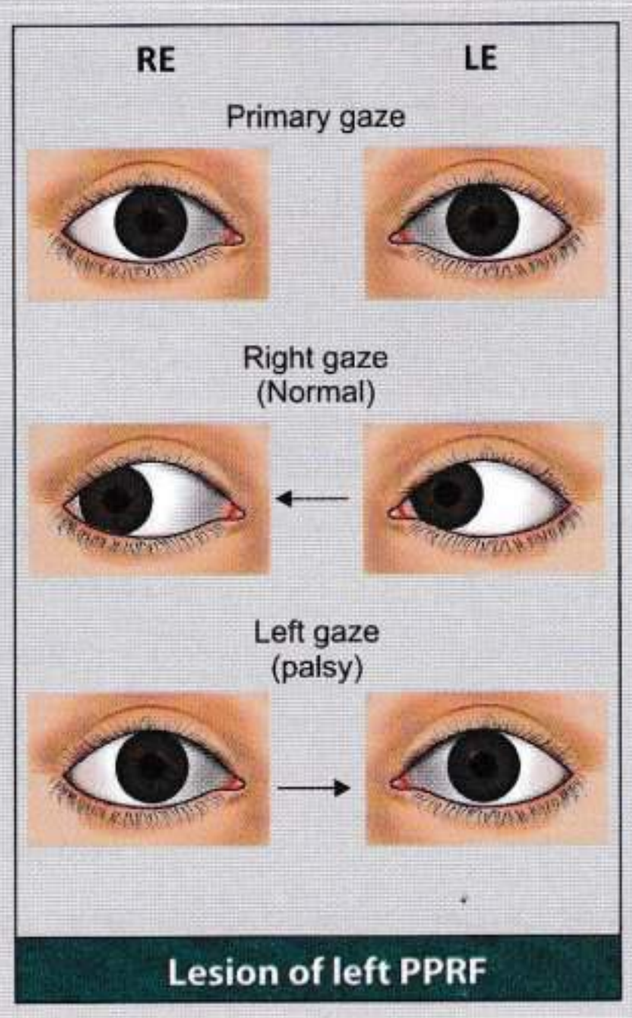
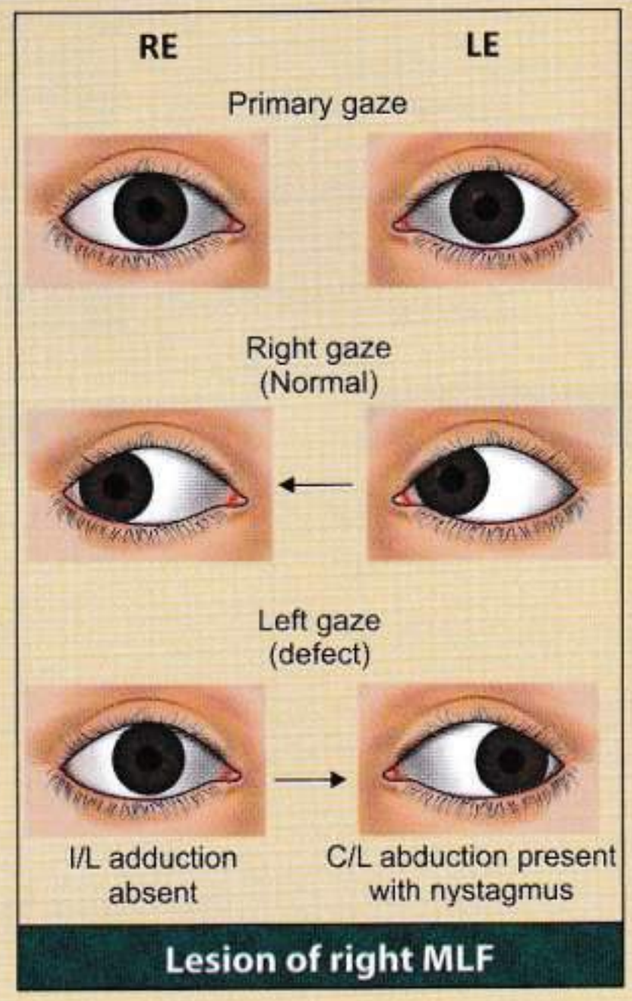
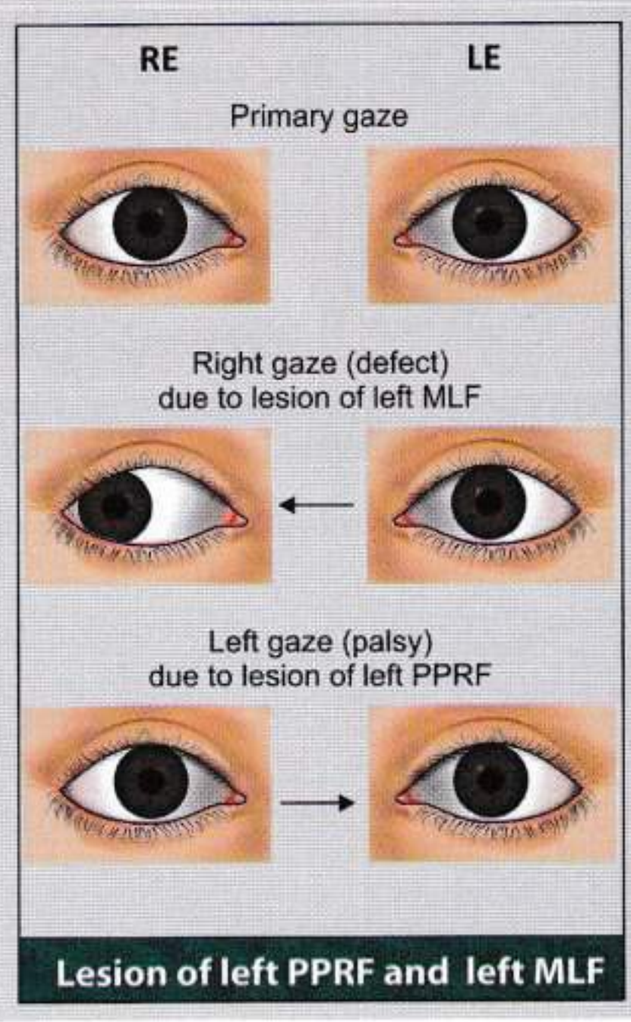
Horizontal Gaze



Anatomical pathway for horizontal eye movements

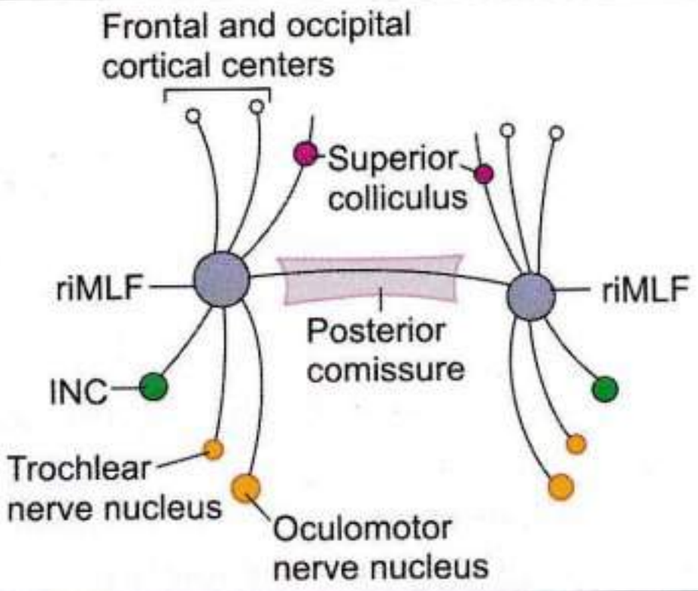
PPRF = paramedian pontine reticular formation; MLF = medial longitudinal fasciculus; MR = medial rectus; LR = lateral rectus

Horizontal Gaze Palsy

PPRF (left)	MLF (right)	PPRF and MLF (left)
Left Gaze Palsy Inability to look in the direction of lesion (Ipsilateral)	**Left Gaze Defect**[Q] • Inability of right ADduction ▪ RMR doesn't receive input • Left ABduction possible but with nystagmus ▪ LLR receives innervation • Convergence is normal This is known as **Internuclear Ophthalmoplegia**[Q] (is contralateral), thus (R) **MLF lesions causes** (R) **INO, causes left gaze defect**	• PPRF lesion causes- (Ipsilateral) left Gaze palsy • MLF lesion causes- (Contralateral) Right gaze defect Known as **One and Half Syndrome** Only Abduction of contralateral eye remains[Q]
 **Lesion of left PPRF**	 **Lesion of right MLF**	 **Lesion of left PPRF and left MLF**

Frontal lobe (right) – Left lateral gaze palsy[Q]

Vertical Gaze



Vertical gaze pathway

Controversy?

- MYTH – Other books centre for vertical gaze – "in the midbrain-the rostral interstitial nucleus [of cajal]
- FACT – Harrison's, 17th edition pg. 194; Kanski 7th ed. Pg. 840; Anatomy & Physiology khurana, 2nd edition pg 308
  - **Centre** for vertical gaze[Q] – in the midbrain–the rostral interstitial medical longitudinal fasciculus **(riMLF)**, just dorsal to the red nucleus
  - **Interstitial nucleus of cajol (INC)**[Q] - is involved in vertical gaze holding and pursuit

Vertical Gaze Palsy

Parinaud's Dorsal Midbrain Syndrome

- Site of **lesion:** Posterior commissure
- Cause:
  - Pinealoma
  - Hydrocephalus from aqueductal stenosis
  - Cysticercosis
- **Clinical features:**
  - Supranuclear **Upgaze**[Q] palsy
  - Collier's Sign – upper eyelid retraction
  - Convergence – retraction nystagmus
  - Light-near dissociation[Q] (Light reflex absent near reflex present)

Progressive Supranuclear Palsy

- Presents in **old age**
- **Clinical features:**
  - **Initial supranuclear Downgaze**[Q] **palsy** → Upgaze palsy → Global Gaze palsy → Convergence palsy
  - Extrapyramidal rigidity, ataxia

Other Causes

- Parkinson's disease
- Huntington's chorea
- Olivopontocerebellar degeneration
- Double elevator palsy/mono-ocular elevation deficit
  Palsy of both elevators (SR & IO) due to supranuclear lesion in the tectum
- Distal basilar artery ischemia – **MC cause of vertical gaze palsy**

EXTRA MILE

Disorders in Higher Visual Function

Visual Agnosia

- **Prosopagnosia:** Inability to recognize familiar faces
- **Object agnosia:** Inability to name or indicate use of an object

Occur due to lesion in inferior occipitotemporal junction

Visual acuity remains normal

Visual Illusions

- **Palinopsia:** Persistence of image for several minutes
- **Optic anesthesia:** False orientation of objects in space
- **Cerebral dyschromatopsia**: Perception of a different/ illusionary colour or no perception of colour

Visual Hallucinations

- Unformed – geometric forms, colours or flashes of lights. Seen in
  - Occipital lobe disease
  - Migraine
  - Optic nerve disease
  - Vitreal pathologies
- Formed – objects, person or animals. Seen in
  - Temporal lobe disease
  - Charles Bonnet syndrome

Balint's Syndrome

- Occurs due to infarctions in the "watershed" area between distal Posterior cerebral artery and Middle cerebral artery territories.
- Bilateral visual association areas are affected.
- Characterized by **palinopsia** – it means persistence of a previous visual image for several minutes and **asimultanagnosia** – inability to synthesize the whole of an image.

MISCELLANEOUS NEURAL CONDITIONS AFFECTING OCULAR MOVEMENT

Ocular Myopathies

Myasthenia gravis	
MC in females around 20-30 years Changes in Postsynaptic membrane • Loss and simplification of postsynaptic folds • Reduced Ach receptors – autoantibody mediated – B cell mediated • Widened synaptic cleft Muscular fatigability is hallmark – improves with rest, worse at the end of the day	**Ptosis** – bilateral and asymmetrical **Cogan lid twitch sign** – brief upshoot of eyelid as eyes saccade from downgaze to primary position **Diplopia** – vertical with total or partial external **ophthalmoplegia** Pupils are normal Ice pack test and Edrophonium[Q] (short acting anticholinestrase agent) test demonstrate a transient improvement of ocular signs and symptoms
Botulism	
Caused by neurotoxin of *Clostridium botulinum* Acts on the Pre-synaptic terminal Type A botulism is most common – food borne Causes respiratory weakness with autonomic dysfunction	**Ptosis,** external **Ophthamoplegia** and **Diplopia** **Internal ophthalmoplegia –** causing loss of accommodation **Pupil –** light-near disassociation seen[Q]
Chronic progressive external ophthalmolegia (CPEO)	
Mitochondrial disorder affecting muscles May occur as • Isolated • Kearns – Sayre syndrome – triad of external ophthalmoplegia, pigmentary (Salt and pepper)[Q] retinopathy and cardiac conduction block • Oculopharyngeal dystrophy	**Ptosis -** 1st sign – bilateral and asymmetrical External **ophthalmoplegia** – upgaze first, lateral gaze and downgaze last affected **Diplopia - RARE**[Q] Ragged red fibres – seen on histology of extraocular muscles due to acculmulation of abnormal mitochondria

Contd...

Myotonic dystrophy
AD; 3rd – 6th decade Anticipation phenomenon present – earlier onset in successive generations Serum creatinine kinase is elevated   Hatchet or Myotonic facies Mournful expression due to bilateral facial muscle wasting
Ptosis – bilateral and slowly progressive External **ophthalmoplegia – RARE** Early onset cataract

Neuro-Ophthalmic Emergencies

Giant cell arteritis	Causes only **Sudden visual loss**, no ophthalmoplegia May also experience diplopia due to infarction of extraocular muscles
Intracranial aneurysm	Ophthalmoplegia (due to 3rd cranial nerve palsy), with ptosis and anisocoria – due to aneurysm in circle of Willis
Cavernous sinus thrombosis	Fever, eye pain, proptosis, orbital congestion, **Ptosis** and **ophthalmoplegia**
Orbital apex syndrome	**Ophthalmoplegia, Ptosis** and **visual loss** with decreased corneal sensation (II, III, IV, VI and first division of V nerves are involved) – Rhinocerebral mucormycosis is the most common cause
Pituitary apoplexy	Painful **ophthalmoplegia** and **visual loss**

LAST MINUTE REVISION – ONE LINERS

- All extraocular muscles take origin from the annulus of zinn except inferior oblique.
- SO4, LR6 and rest extraocular muscles – 3rd cranial nerve.
- The longest and the thinnest muscle is the superior oblique.
- Shortest muscle with the shortest muscle tendon is the inferior oblique.
- Clinical actions of extraocular muscles
  - SR – elevation in abduction
  - IO – elevation in adduction
  - SO – depression in adduction
  - IR – depression in abduction
- Versions are conjugate (same side) movements and Vergences are disjugate (different side).
- Yoke muscles are a pair of muscles which help to perform a conjugate/version movement of both the eyeballs
  - RSR and LIO – Dextroelevation
  - RIR and LSO – Dextrodepression
  - LSR and RIO – Levoelevation
  - LIR and RSO – Levodepression
- Secondary deviation is based on the Hering's law of equal innervations.
- Diplopia occurs in cases of small angle squint and Confusion in cases of Large angle squint.
- Abnormal head posture and Suppression are seen in cases of confusion as adaptations whereas ARC and Fusion are seen for adapting with diplopia.
- RAF ruler can be used to measure the power of Vergence/fusion needed to overcome retinal image disparity.
- Hirschberg's corneal reflex test is used to measure the degree of deviation with 1mm = 7 degree or if the corneal reflex is seen at pupillary margin than 15 degree and if at limbus 45 degree.
- Cover – Uncover test is the only test that can differentiate between Tropia and Phoria.
- Worth four dot test is a dissociation test – used to differentiate between BSV, ARC and suppression. It consists of a box with 1 red, 2 green and 1 white light.
- Hess screen, lee's chart and red green goggles are used to diagnose Diplopia.
- Pseudoesotropia is the most common pseudo-squint and is due to high myopia, telecanthus, epicanthus, narrow IPD.
- Pseudoexotropia occurs due to Retinopathy of prematurity, hypermetropia, hypertelorism.
- Esophoria is seen in Hypermetropic children.
- In Comitant squint degree of squint is same in all directions of gaze, with primary deviation being equal to secondary deviation and sensory anomalies present.
- In Incomitant squint, degree of deviation varies in all directions of gaze with primary deviation being less than secondary, with presence of diplopia, abnormal head posture.
- Essential infantile esotropia is associated with latent nystagmus, DVD, IO overaction.
- Refractive accommodative comitant esodeviation – has normal AC/A ratio – most common in 2–3 year old hypermetropic children.
- Forced duction test can be used to differentiate between paralytic and restrictive squint.
- III cranial nerve palsy presents with ptosis, down and out eyeball, mydriasis, loss of accommodation and crossed diplopia.
- Isolated III cranial nerve palsy with pupillary sparing is seen in diabetes mellitus.
- IV cranial nerve palsy presents with iplsilateral hypertropia, increase in hypertropia with adduction and vertical diplopia on looking downstairs.
- Park's 3 step test/ Bielchowsky head tilt is useful to evaluate the head posture in cases of IV cranial nerve palsy, with hypertropia becoming better in Head tilt to opposite side and worse in gaze towards opposite side.
- VI cranial nerve palsy presents with ipsilateral esotropia with face turn to the same side with uncrossed diplopia and ipsilateral horizontal gaze palsy.
- Type 3 DRS presents with limitation of both abduction and adduction.
- Horizontal gaze is controlled by contralateral Frontal eye field, ipsilateral PPRF and contralateral MLF.
- One and a half syndrome is seen in lesion of ipsilateral PPRF and MLF.
- MLF lesion leads to defective contralateral gaze with limitation of ipsilateral adduction.
- Centre for vertical gaze is rostral interstitial medial longitudinal fasiculus (riMLF).
- Perlia nucleus–centre for convergence

BONUS PAGE 2

NYSTAGMUS

- Greek: nystagmus = to nod. Nystagmus may be defined as repetitive, to and fro involuntary movement of one or both eyes that is initiated by a slow phase.
- Movements which are not regular and rhythmic are called nystagmoid movements.

Features of Nystagmus Movements

Type and Direction of Waveform

- **Pendular:** movements of equal velocity in each direction. It can be horizontal, vertical, rotator, oblique.
- **Jerk:** slow component in one direction and a fast component in other direction. Fast component is a recovery movement for re-fixation. Direction of jerk nystagmus is defined by direction of fast component.

  Fast component can be
  - To the right (right beating nystagmus)
  - To the left (left beating nystagmus)
  - Up (up beating nystagmus)
  - Down (down beating nystagmus)
  - Right rotatory (anti-clockwise)
  - Left rotatory (clockwise)

Conjugacy

- **Conjugate:** Binocular nystagmus with symmetric direction, amplitude and rate in both eyes
- **Disconjugate:** Monocular or binocular nystagmus with different directions and frequencies in two eyes
- **Dissociative:** Unidirectional but asymmetrical nystagmus in two eyes. Seen in internuclear ophthalmoplegia[Q].

Classification

COWS - Classification of Eye Movement Abnormalities and Strabismus

Physiological Nystagmus

Optokinetic nystagmus	End point nystagmus	Vestibular nystagmus
Physiological jerk nystagmus induced by presenting to gaze the objects moving serially in one direction. E.g. while looking at outside things from a moving train	Fine jerk horizontal nystagmus seen in normal persons on extreme right or left gaze	Elicited by stimulating the tympanic membrane with hot or cold water [(caloric test): COWS (Cold: Opposite, Warm: Same)]

Pathological Nystagmus

Infantile nystagmus syndrome	Ocular albinism, Leber's congenital amaurosis, bilateral congenital cataract, achromatopsia, congenital stationary night blindness, bilateral optic nerve hypoplasia, bilateral congenital toxoplasmosis, bilateral macular hypoplasia
Spasmus nutans syndrome	Presents in infancy with torticollis, head nodding and dysconjugate eye movements, resolves by 3 years
Fusion maldevelopment nystagmus syndrome	Associated strabismus, appears when one eye is covered, intensity decreases with age

Sea-saw nystagmus[Q]	Diseases affecting the optic nerve and optic chiasm, e.g. Behr hereditary optic neuropathy
Downbeat nystagmus[Q]	Lesions affecting excitatory projections from cerebellum[Q] and posterior semicircular canals, e.g. Arnold Chiari malformation[Q], lithium toxicity, Phenytoin, alcohol
Upbeat nystagmus	Wernicke's encephalopathy, posterior fossa lesions
Bruns nystagmus	Acoustic neuroma
Latent nystagmus (manifested on cobering the eye)	Essential infantile esotropia, Dissociated vertical deviation (DVD) (Most common nystagmus associated with strabismus – Manifest-latent nystagmus)
Convergence retraction nystagmus	Parinaud dorsal midbrain syndrome[Q], Aqeductal stenosis with pinealoma or hydrocephalus
Vestibular nystagmus	Central – due to demyelinating disease, peripheral due to 8th cranial nerve disease Presents with Oscillopsia – (perception of spinning around the world)
Periodic alternating nystagmus	Cerebellar disease, Ataxia telangiectasia

Nystagmoid Movements

Ocular bobbing	Rapid, conjugate, downward movement; slow return to primary position	**Pontine lesions**[Q]**,** Metabolic encephalopathy
Ocular dipping (Inverse bobbing)	Slow downward movement; rapid return to primary position	Anoxic brain injury
Reverse ocular bobbing	Rapid upward movement; slow return to primary position	Metabolic encephalopathy
Reverse ocular dipping	Slow upward movement; rapid return to primary position	AIDS with cryptococcal meningitis
Ping-pong gaze	Horizontal conjugate deviation of the eyes, alternating every few seconds	Metabolic encephalopathy, bilateral cerebral hemispheric dysfunction; toxic ingestion
Vertical myoclonus	Vertical pendular oscillations (2–3 Hz)	Pontine strokes
Horizontal myoclonus	Rapid horizontal pendular oscillations; the eyes appear to be shaking	Serotonin toxicity

There are multiple probable questions that can be asked on a single image.

Question numbers 1 to 4 are based on Image 1.

Image 1

1. **What is the diagnosis for the child in the above photograph?**
   a. Left exotropia b. Right esophoria
   c. Right exotropia d. Left esotropia
2. **Which test is being done in the above patient for Squint?**
   a. Maddox rod test
   b. Hirschberg's Corneal reflex test
   c. Worth's Four dot test d. Cover uncover test
3. **What is the degree of deviation in the right eye?**
   a. 30 degree b. 45 degree
   c. 45 prism diopter d. 30 prism diopter
4. **All of the following may be probable causes for the Squint in the child except**
   a. Myopia
   b. Nystagmus blockage syndrome
   c. Duane's retraction syndrome type II
   d. Right Internuclear ophthalmoplegia

Question numbers 5 to 8 are based on Image 2.

Image 2

5. **Diagnose the ocular condition in the photograph.**
   a. Right esotropia b. Right exotropia
   c. Left esotropia d. Left exotropia
6. **All of the following can cause the above except**
   a. Nystagmus blockage syndrome
   b. Myasthenia gravis
   c. Convergence insufficiency
   d. 6th nerve paralysis
7. **The best test to measure the deviation in the above patient is**
   a. Maddox rod test
   b. Prism Bar cover test
   c. Hirschberg's corneal reflex test
   d. Worth's four dot test
8. **The above (photo) infant is referred by his pediatrician for evaluation of esotropia. Examination reveals esotropia in the primary position with markedly limited abduction of the left eye, although there is minimal restriction of adduction of the left eye with lid fissure narrowing on attempted adduction. Right ocular motility and fissure height are normal. The case most likely represents**
   a. DRS I
   b. DRS II
   c. DRS III
   d. Brown's syndrome

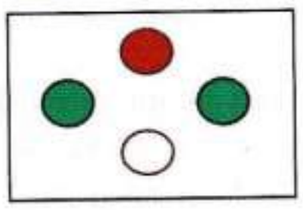
Question numbers 9 to 13 are based on Image 3.

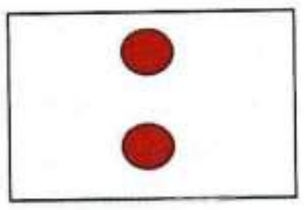
Image 3

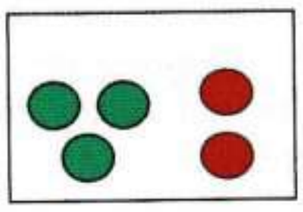
9. **The instrument in the above photograph is used for which of the following tests**
   a. The circles test
   b. TNO random dot test
   c. Bagolini Striated glasses
   d. Worth four dot test
10. **Worth Four Dot Test (WFDT) is done for**
    a. Color deficiency
    b. Strabismus
    c. Binocular vision
    d. Nystagmus
11. **The test done by the instruments in the above photograph can be used for diagnosing all of the following conditions except**
    a. Anomalous retinal correspondence without manifest squint
    b. Suppression
    c. Normal retinal correspondence with manifest squint
    d. Diplopia

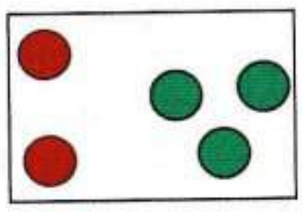
Most Recent Image-based Questions of 2019-2017 are given at the end

12. **A 45-year-old male patient complains of loss of vision in his left eye. He has history of trauma to the head a few months back. On examination, his anterior segment is normal, fundus also appears normal. He has 45 degree esotropia in the left eye. On the above test (red glass in front of right eye), the patient will see**

a. 

b. 

c. 

d. 

13. **All of the following are true regarding the test done with the above instrument except**
    a. It is the most physiological test for Binocular singe vision
    b. It is normally done at 6 meters of distance
    c. It is useful only in cases of Tropia
    d. It can be used with both distance and near fixation

Question numbers 14 to 19 are based on Image 4.

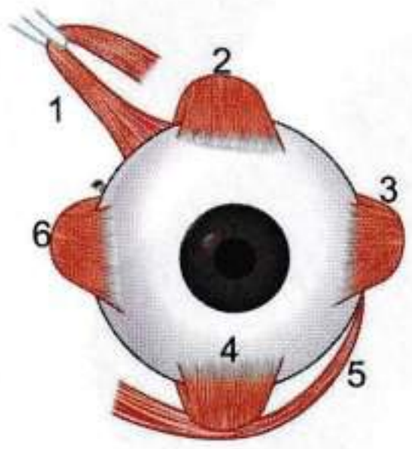


Image 4

14. **Identify the structure marked 1 in the above image.**
    a. Superior Tarsus
    b. Superior rectus
    c. Superior oblique
    d. Levator palpebri superioris
15. **Which extraocular muscles abduct the eye?**
    a. 1,4,6
    b. 1,3,5
    c. 2,6
    d. 2,3,4
16. **What is the function of the muscle marked 1 in the image.**
    a. Dextroversion
    b. Dextroelevation
    c. Dextrodepression
    d. Levodepression
17. **Which of the following muscles does not originate from the Orbital Apex?**
    a. 2 b. 1
    c. 3 d. 5
18. **Which of the above muscles inserts closest to the Limbus?**
    a. 6 b. 2
    c. 4 d. 3
19. **The nerve supply of muscle marked 4 in the above image is**
    a. Trochlear nerve
    b. Inferior division of the Oculomotor nerve
    c. Superior division of the Oculomotor nerve
    d. Abducens nerve

Question number 20 is based on Image 5.

Image 5

20. **The optical instrument in the above image is used for diagnosing all except**
    a. Diplopia charting
    b. Binocular single vision
    c. Entoptic phenomenon
    d. Amblyopia

Question numbers 21 to 23 are based on Image 6.

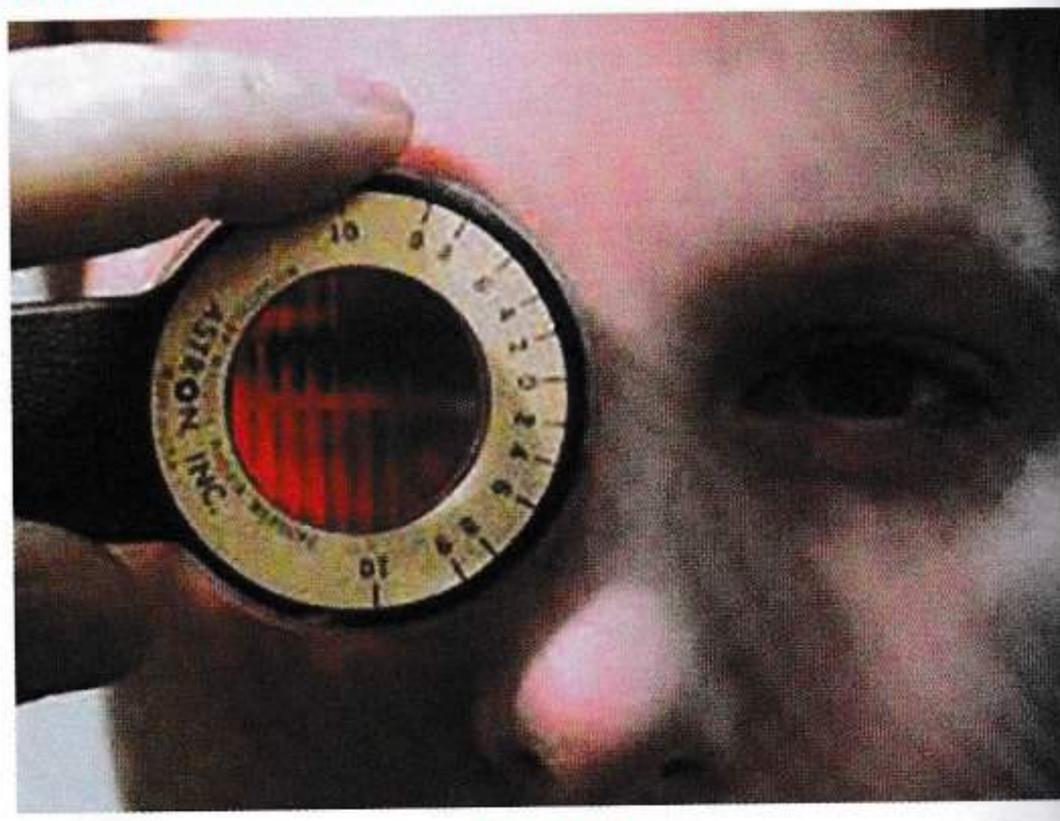
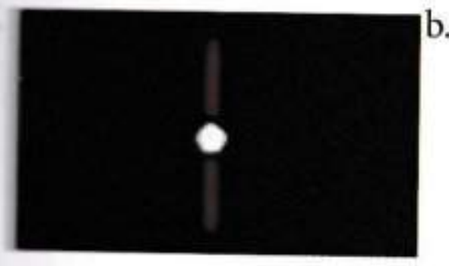
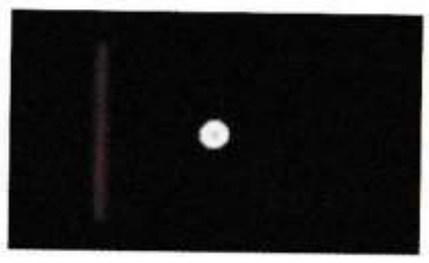
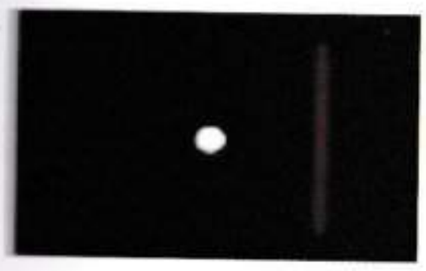


Image 6

21. **Which investigation is being done for the patient in the above image?**
    a. Retinoscopy
    b. Fincham's test
    c. Jackson's cross cylinder test
    d. Maddox rod test
22. **All of the following are true about the above instrumen except**
    a. Both horizontal and vertical deviations can be measured
    b. Used to test macular function
    c. It can differentiate between a phoria and tropia
    d. It is based on the principle of disassociation of the eyes

Most Recent Image-based Questions of 2019-2017 are given at the end

23. What will be the result of the test for a patient who has esophoria?

a. 
b. 
c. 
d. Any of the above

Question numbers 24 and 26 are based on Image 7.

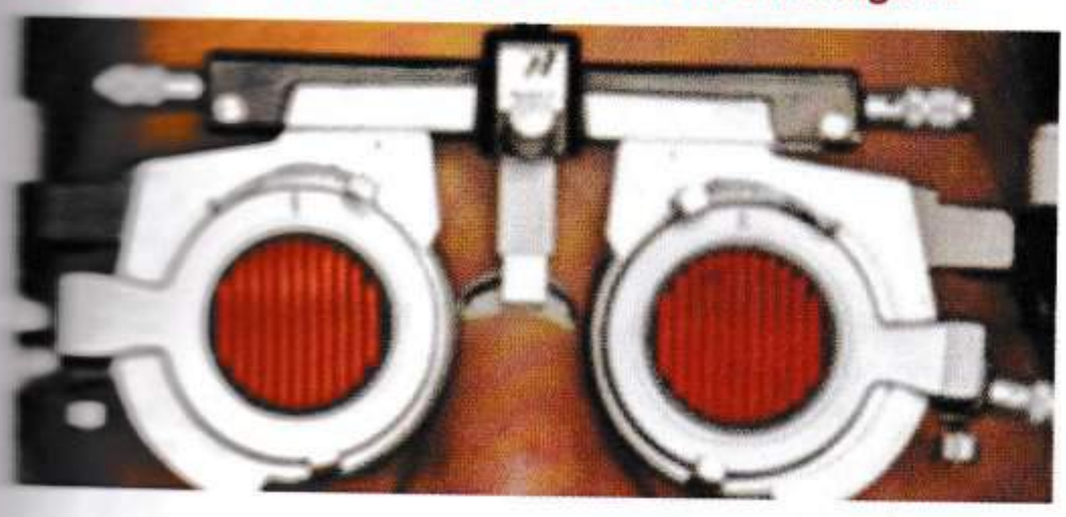


Image 7

24. Identify the test being done in the image.
a. Maddox wing test
b. Bagolini striated glasses
c. Pin hole test
d. Maddox rod test

25. The investigation being done in the above patient is used to
a. Test deviations in both the eyes simultaneously
b. Diagnose cyclotropia
c. Macular function test
d. All of the above

26. Identify the investigation being done.
a. Maddox Wing *(Recent question Jan 2018)*
b. Maddox rod
c. Maddox groove
d. Jackson's cross cylinder test

Question numbers 27 to 31 are based on Image 8.

Image 8

27. **The patient in the above photograph is most likely suffering from**
a. Ptosis
b. Proptosis
c. Horner's Syndrome
d. Oculomotor nerve paralysis

28. **All of the following can lead to the above condition (photograph) except**
a. Foville syndrome
b. Diabetes
c. Pitutary apoplexy
d. Weber's syndrome

29. **All of the following are features of squint in the above patient (photograph) except**
a. Diplopia
b. Primary deviation = secondary deviation
c. Abnormal head posture may be seen
d. Early surgery is not needed

30. **Which of the following can be the cause of the condition in the above patient?**
a. Botulism
b. Trauma
c. Basal meningitis
d. Uncal herniation

31. **All of the following are true about the above patient except**
a. Forced duction test is negative
b. Pseudo-von graefe sign may be seen
c. Periosteal anchoring of the lateral rectus should be contemplated after 6 months
d. It is a case of nuclear 3rd nerve palsy

Question number 32 is based on Image 9.

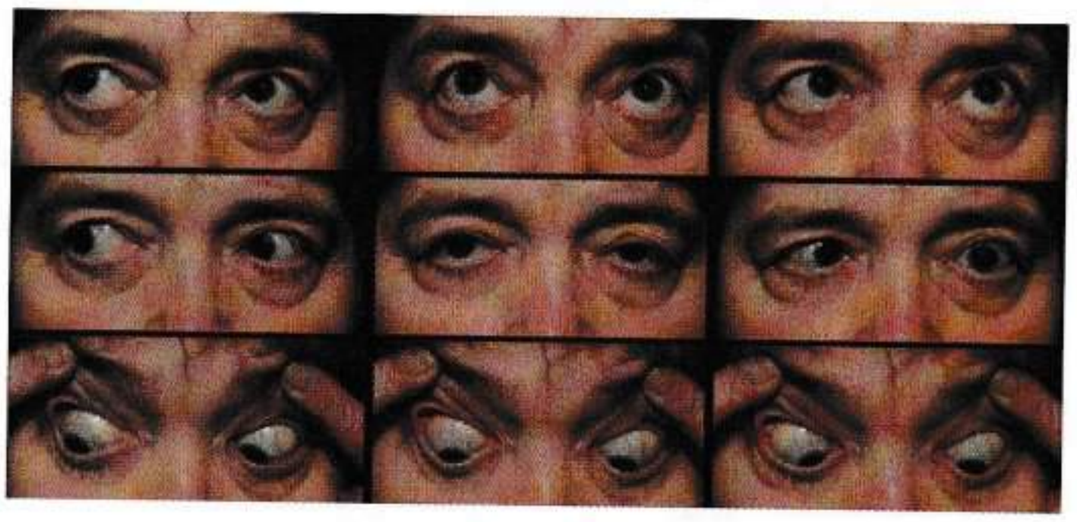


Image 9

32. **The patient in the above photograph is suffering from**
a. Left lateral rectus palsy
b. Left Internuclear Ophthalmoplegia
c. Left DRS Type 1
d. Mysthaenia gravis

Question numbers 33 and 34 are based on Image 10.

Image 10

Most Recent Image-based Questions of 2019-2017 are given at the end

33. **Diagnose the ophthalmic deformity in the infant.**
   a. Epicanthus
   b. Microblepharon
   c. Hypertelorism
   d. Telecanthus

34. **Diagnose the strabismus in the patient.**
   a. Pseudoexotropia
   b. Esophoria
   c. Pseudoesotropia
   d. Esotropia

Question numbers 35 and 36 are based on Image 11.

Image 11

35. **Which of the following muscles are responsible for the movement of the eye seen in the image?** ***(Recent Pattern 2016)***
   a. RLR & LMR
   b. RSO & LIR
   c. LSR & RIO
   d. RSR & LIO

36. **Which direction of gaze is shown in the image?**
   a. Dextrolelevation – Tertiary gaze
   b. Dextroelevation – Secondary gaze
   c. Elevation – Primary gaze
   d. Levoelevation – Secondary gaze

Question number 37 is based on Image 12.

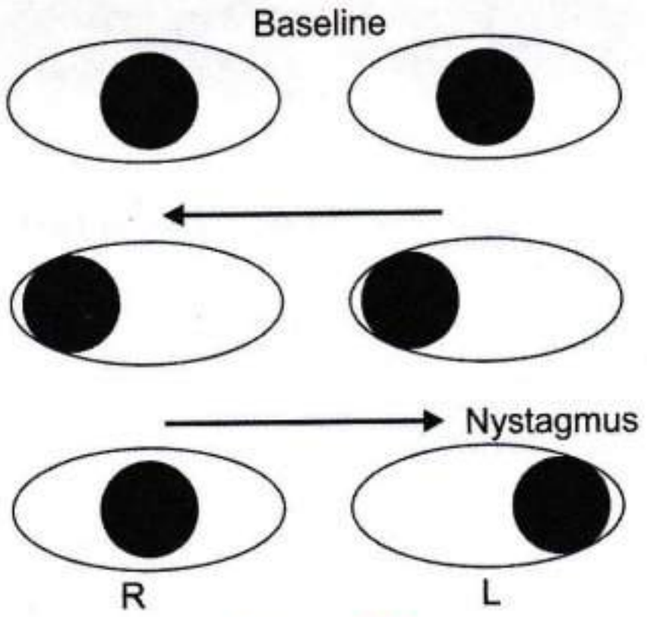


Image 12

37. **Evaluate and diagnose.** ***(AIIMS Nov 2016)***
   a. Horizontal gaze palsy
   b. Internuclear ophthalmoplegia
   c. Internal ophthalmoplegia
   d. Duane's retraction syndrome

Question number 38 is based on Image 13.

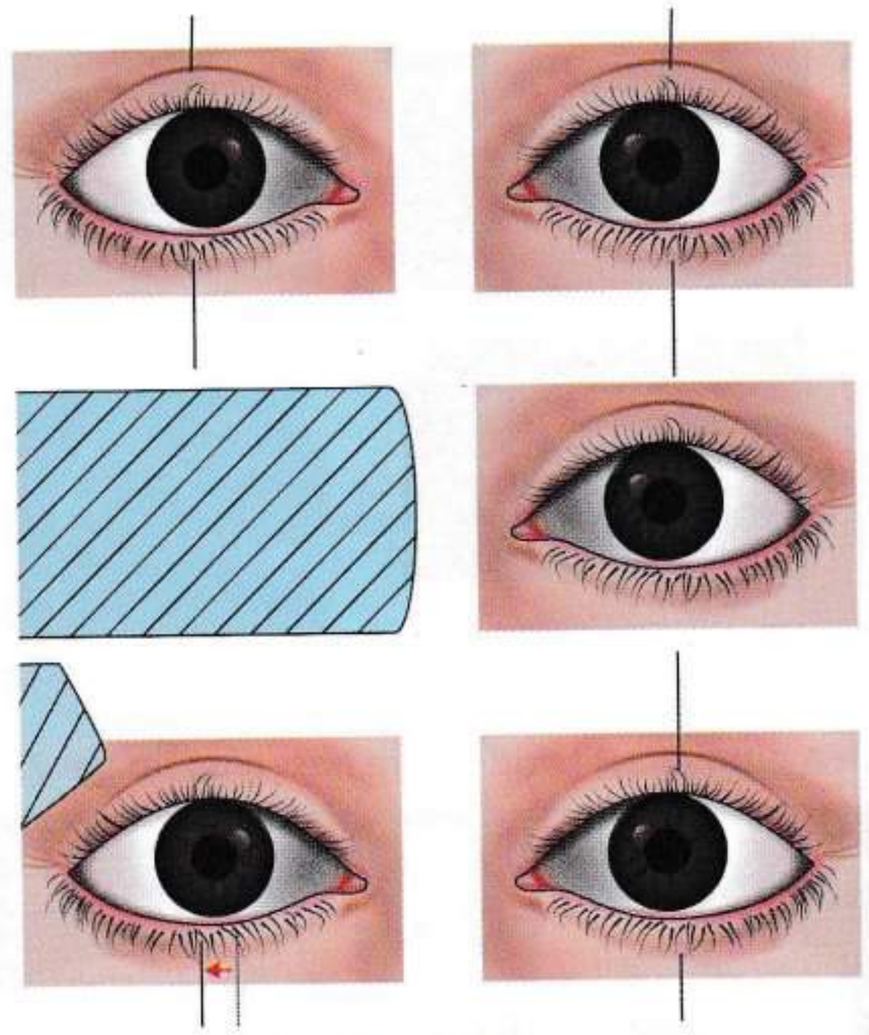


Image 13

38. **Diagnose**
   a. Esotropia
   b. Esophoria
   c. Exotropia
   d. Exophoria

Question number 39 is based on Image 14.

Image 14

39. **Test done in the image is used for diagnosis of** ***(Recent pattern Dec 2015)***
   a. Nystagmus
   b. Heterophoria
   c. Amblyopia
   d. Proptosis

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Question number 40 is based on Image 15.

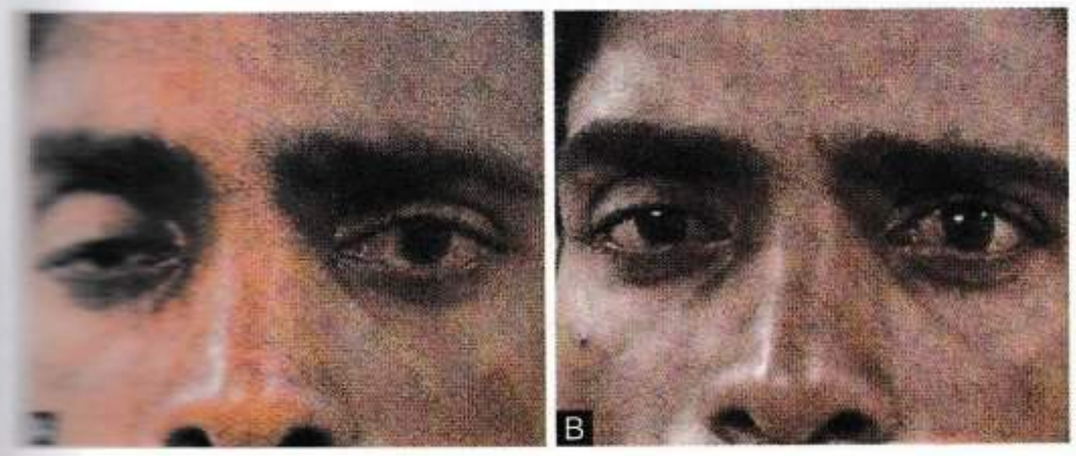


Image 15

40. A patient presented with the findings in Image A. After giving an IV drug to the patient, in 5 mins his condition improved (Image B). What is the probable diagnosis? *(AIIMS Nov 2017)*

a. Sixth nerve palsy
b. Myasthenia gravis
c. Third nerve palsy
d. Tolosa Hunt syndrome

Question number 41 is based on Image 16.

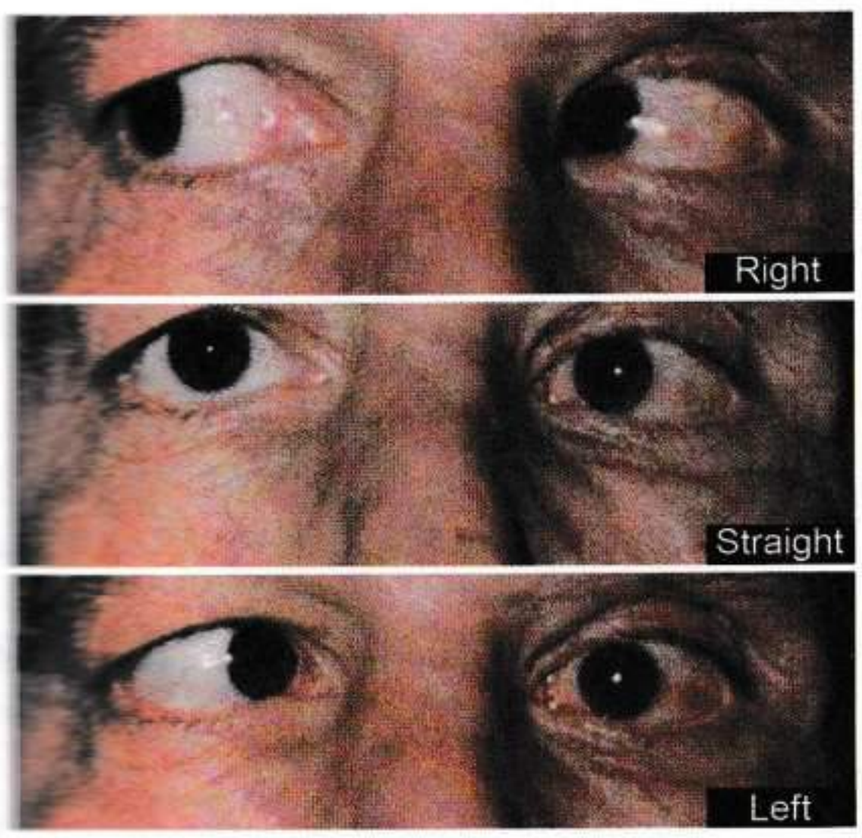


Image 16

41. What is the diagnosis? *(AIIMS Nov 2017)*

a. 3rd nerve palsy
b. 4th nerve palsy
c. 6th nerve palsy
d. 2nd nerve palsy

Question number 42 is based on Image 17.

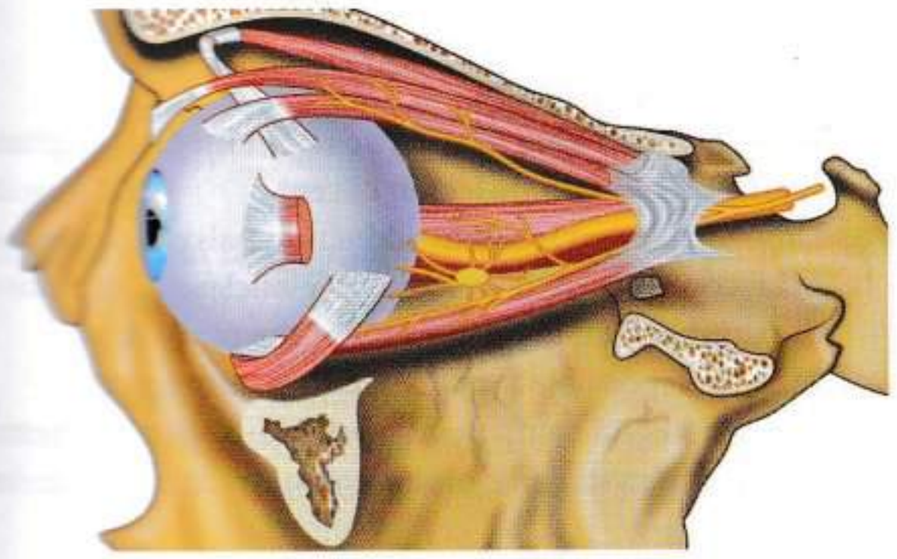


Image 17

42. In the image 17, the nucleus for the marked muscle lies at which level in the brain *(AIIMS May 2017)*

a. Superior colliculus
b. Inferior colliculus
c. Facial colliculus
d. Raphe nucleus

Most Recent Image-Based Questions of 2019-2017

Question number 43 is based on Image 18.

Image 18

43. Diagnose the condition. *(AIIMS Nov 2018)*

a. 3rd cranial nerve palsy
b. Superior oblique palsy
c. Lateral rectus Palsy
d. Internuclear ophthalmoplegia

Question number 44 is based on Image 19.

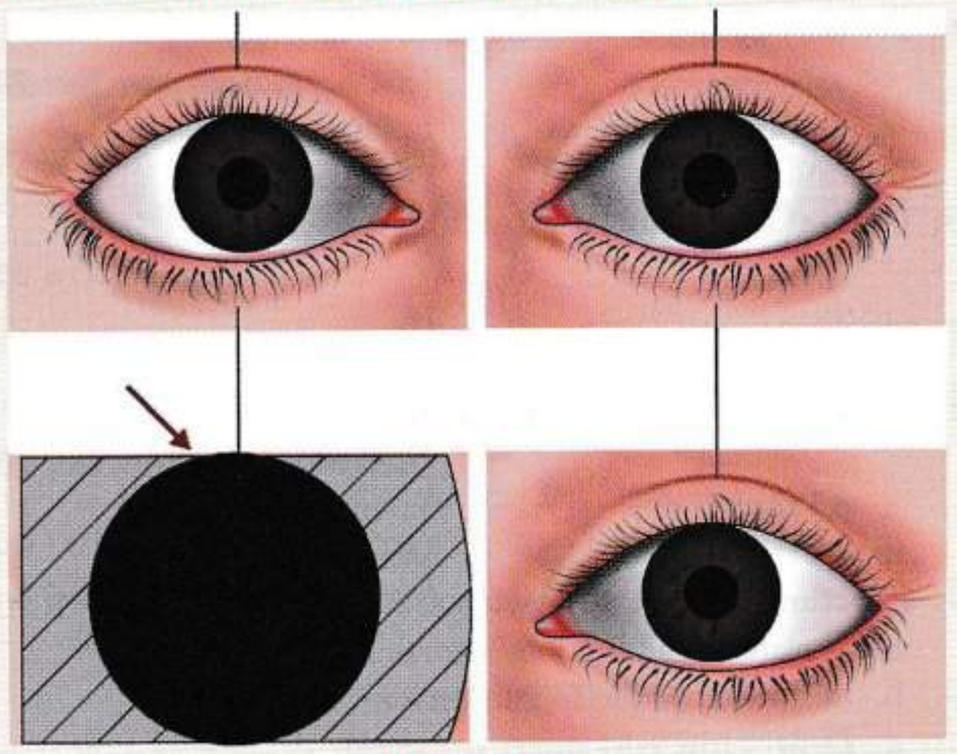


Image 19

44. Which of the following tests is being done in the image shown *(Recent question Jan 2019)*

a. Cover test
b. Prism bar cover test
c. Occluder test
d. Uncover Test

Most Recent Image-based Questions of 2019-2017 are given at the end

MULTIPLE CHOICE QUESTIONS

Extraocular Muscles and Binocular Single Vision

45. Superior rectus muscle is supplied by *(Recent pattern Nov/Dec 2016)*

a. Superior branch of Oculomotor nerve
b. Trochlear nerve
c. Abducens nerve
d. Inferior branch of Oculomotor nerve

46. Action of superior oblique muscle: *(PGI Nov 2013)*

a. Adduction
b. Intorsion
c. Elevation
d. Extorsion
e. Depression

47. Inferior rectus muscle characteristics are: *(PGI May 2011)*

a. Insertion- 6.5 cm behind limbus
b. Lies inferior to inferior oblique muscle
c. Main depressor when adducted
d. Attached to lower part of common tendinous ring
e. Innervations through inferior surface of the muscle

48. Primary action of inferior oblique is *(Recent pattern Nov/Dec 2016)*

a. Elevation
b. Extorsion
c. Abduction
d. Depression

49. Longest and thinnest extrocular muscle is *(Recent pattern 2014)*

a. SR
b. IR
c. SO
d. IO

50. Distance of medial rectus from limbus is *(Recent pattern Nov/Dec 2016)*

a. 4.5 mm
b. 5.5 mm
c. 7.0 mm
d. 10 mm

51. Functions of superior rectus are: *(DNB 2012)*

a. Elevations, adduction, extortion
b. Elevation, adduction, intorsion
c. Depression, adduction, intorsion
d. Depression, adduction, extortion

52. Which of the following is not true about inferior oblique muscle? *(Recent pattern Nov/Dec 2016)*

a. It is the shortest muscle
b. Its primary action is extorsion
c. It originates from the annulus of Zinn
d. It is supplied by the third cranial nerve

53. Superior oblique testing for 4th nerve is done by checking its intorsion while asking the subject to look– *(Recent pattern 2014)*

a. Straight down
b. Straight up
c. Down and in
d. Down and out

54. The reciprocal inhibition of antagonist muscle upon lateral gaze is explained by *(AIIMS May 2008)*

a. Sherrington's law
b. Hering's law
c. Laplace law
d. Hick's law

55. Yoke muscle for left superior rectus is– *(Recent pattern Nov/Dec 2016)*

a. Right superior rectus
b. Left inferior rectus
c. Right inferior oblique
d. Right superior oblique

56. For Dextroelevation of eye, muscles acting are – *(Recent pattern 2015)*

a. Right lateral rectus and left medial rectus
b. Right superior rectus and left inferior oblique
c. Right inferior rectus and left superior oblique
d. Bilateral superior recti and inferior obliques

57. All of the following are yoke muscles except: *(Recent pattern 2015-2016)*

a. Right medial rectus and left lateral rectus
b. Right superior rectus and left inferior oblique
c. Right superior oblique and left inferior rectus
d. Right inferior rectus and left inferior oblique

58. Yolk muscle pair is *(Recent pattern 2012-13)*

a. Rt MR and Rt LR
b. Rt MR and Lt LR
c. Rt SO and Lt IO
d. Rt SR and Lt SR

59. Which one of the following extraocular muscles is served by a contra lateral brainstem subnucleus?

a. Superior rectus
b. Medial rectus
c. Inferior oblique
d. Inferior rectus

Tests for Strabismus

60. Which of the following is the nucleus for upward gaze? *(AIIMS May 2018)*

a. Raphe nucleus
b. Cuneiform nucleus
c. Interstitial nucleus of cajal
d. PPRF

61. 15-year-old female came to the OPD with history of fever headache and blurring of vision for the past 1 week. She also complaints of diplopia since 1 day on looking to the right side. Which of the following is the most likely cause for her condition? *(AIIMS May 2018)*

a. Cranial neuritis
b. Chronic meningitis
c. Internuclear ophthalmoplegia
d. Demyelinating disease

62. Which of the following is/are true about medial longitudinal fasciculus (MLF) and its lesion except *(PGI May 2017)*

a. Unilateral lesion result in adduction palsy of opposite eye
b. MLF connects sixth cranial nerve nucleus of one side with the third cranial nerve nucleus of the other side
c. MLF is responsible for conjugate eye movements
d. It is an integral component of saccadic eye movements
e. Abducting nystagmus of the eye contralateral to the lesion

Most Recent Questions of 2019-2017 are given at the end

test is done for the diagnosis of *(Recent pattern Nov/Dec 2015)*

a. Diplopia
b. Binocular single vision
c. Squint
d. Color blindness

Component of Worth four dot test - *(Recent pattern Nov/Dec 2016)*

a. 2 green, 1 red, 1 white
b. 2 white, 1 green, 1 red
c. 2 red, 2 green, 2 white
d. 1 green, 1 red, 1 white

On measurement of deviation in a patient with VI cranial nerve palsy, 6 prism dioptre distance esodeviation is seen. How far apart do the images of a fixation light at 6m appear to him.

a. 64 cm
b. 24 cm
c. 36 cm
d. 48 cm

The least physiological test for BSV

a. Worth four dot test
b. Bagolini striated glasses
c. Synoptophore
d. After image testing

Angle of squint is measured by *(Recent pattern Nov/Dec 2016)*

a. Gonioscopy
b. Prism
c. Retinoscopy
d. Keratometry

Pseudostrabismus

Child with mild squint. Intrauterine, birth history, developmental history till date all normal. Corneal reflex normal. All other eye parameters normal except *exaggerated epicanthal fold*. Diagnosis– *(Recent pattern 2015)*

a. Pseudostrabismus
b. Accommodative squint
c. Exophoria
d. Esophoria

Pseudoexotropia is seen in the following condition

a. Retinopathy of prematurity
b. Diabetic retinopathy
c. Myopia
d. Telecanthus

Comitant Strabismus

Following is a feature of comitant squint – *(Recent pattern Nov/Dec 2016)*

a. Constant amount of deviation in all directions of gaze
b. Associated limitation of ocular movements
c. Different amount of deviation in different directions of gaze
d. Develops in the patients at 15–20 years of age

In concomitant squint *(Recent pattern 2014)*

a. Primary deviation > Secondary deviation
b. Secondary deviation > Primary deviation
c. Primary deviation = Secondary deviation
d. None

True about congenital esotropia: *(Recent pattern Nov. 2015)*

a. Amblyopia may develop
b. Angle of deviation is usually fixed & large
c. Surgery should be done after 2 year
d. Onset only after 1 year of age
e. May be associated with inferior oblique overaction

73. Miotics are used in: *(JIPMER 2013)*

a. Divergent squint
b. Convergent squint
c. Paralytic squint
d. All

74. Which is most consistent with accommodative esotropia?

a. Dissociated vertical deviation
b. Onset from infancy to 4 years of age
c. Hypermetropia of 8.00 D
d. Poor to no binocular potential

75. Disscociated vertical deviation seen in – *(Recent pattern Nov/Dec 2016)*

a. AV dissociation
b. Infantile esotropia
c. Sensory esotropia
d. Superior oblique palsy

76. A 3-year-old child has esotropia in the right eye. On retinoscopy there is +4.5D hyperopia in right eye and +4D hyperopia in the left eye. The AC/A ratio is normal. What is the probable diagnosis: *(JIPMER 2015)*

a. Infantile esotropia
b. Refractive accommodative esotropia
c. Non-refractive accommodative esotropia
d. Duane's retraction syndrome

Incomitant Strabismus

77. Paralytic squint – which of the following is seen - *(Recent pattern 2016)*

a. Abnormal head posture
b. Amblyopia
c. Diplopia
d. Constant deviation in all directions of gaze

78. Oculomotor nerve palsy causes all except: *(AIIMS Nov 2011)*

a. Miosis
b. Ptosis
c. Outward eye deviation
d. Diplopia

79. III nerve palsy with pupillary sparing is seen in – *(AIIMS Nov 2009, May 1995)*

a. Craniopharyngioma
b. Hypertension
c. Aneursym of posterior communicating artery
d. Diabetes Mellitus

80. Crossed Diplopia is seen in - *(Recent pattern 2016)*

a. 4th cranial nerve palsy
b. 3rd cranial nerve palsy
c. 6th cranial nerve palsy
d. All of the above

81. A 35 year old male is not able to adduct his left eye while looking to the right. It indicates a lesion of which of the following cranial nerves? *(Recent pattern Nov 2015)*

a. Abducens nerve
b. Oculomotor nerve
c. Trochlear nerve
d. Trigeminal Nerve

82. All are characteristics of 3rd nerve except *(AIIMS Nov 2006)*

a. Carries parasympathetic nerve
b. Supplies inferior oblique
c. Enters orbit through the inferior orbital fissure
d. Causes miosis

83. Ataxia, nystagmus and ophthalmoplegia is seen in *(Recent pattern 2012-13)*

a. Myasthenia gravis
b. Chronic progressive external ophthalmoplegia
c. 3rd nerve palsy
d. None

Most Recent Questions of 2019-2017 are given at the end

84. **Diplopia in Superior Oblique palsy is most correctly described as:** *(All India 2011)*
   a. Vertical on looking down
   b. Vertical on looking up
   c. Horizontal on looking in
   d. Horizontal on looking out

85. **A patient complaints of diplopia on downgaze. It is due to palsy of** *(JIPMER 2016)*
   a. 3rd cranial nerve b. 4th cranial nerve
   c. 6th cranial nerve d. Any of the above

86. **Right trochlear nerve palsy can lead to all except:** *(AIIMS May 2015)*
   a. Diplopia on downward gaze and adduction
   b. Right head tilt c. Excyclotropia
   d. Hypertropia of right eye

87. **A patient presented with his head tilted towards right. On examination, he was having left Hypertropia which is increased on looking towards right or medially. The muscle which is most likely paralyzed is** *(AIIMS May 2008)*
   a. Left superior oblique b. Left inferior oblique
   c. Right superior oblique d. Right inferior oblique

88. **Right esotropia is evident with** *(Recent pattern 2015)*
   a. Left lateral rectus paralysis
   b. Right lateral rectus paralysis
   c. Left medial rectus paralysis
   d. Right medial rectus paralysis

89. **Uncrossed Dipolopia is seen in palsy of all except**
   a. MR b. LR
   c. SO d. IO

90. **Head posture in right lateral rectus palsy** *(Recent pattern 2016)*
   a. Head turn to the right side
   b. Head tilt to the right side
   c. Chin elevation
   d. Head turn to the left side

91. **Left sided sixth nerve palsy would lead to** *(AIIMS Nov 2008)*
   a. Accommodation paresis of left eye
   b. Ptosis of left eye
   c. Adduction weakness of left eye
   d. Diplopia in left gaze

92. **Weakness of both Adduction and Abduction is seen in:**
   a. Duane's Retraction Syndrome Type 1 *(AIIMS May 2012)*
   b. Duane's Retraction syndrome Type 2
   c. Duane's Retraction syndrome Type 3
   d. All

93. **A child presents with both eyes in the adducted position. To best determine if this is the result of bilateral lateral rectus palsy, you could try each of the following except**
   a. Doll's head movements
   b. Saccadic eye movements generated by OKN drum
   c. Patching one eye and testing ductions
   d. Forced duction test

Supranuclear Control of Eye Movements

94. **Final common pathway for horizontal gaze involves:** *(All India 2008)*
   a. Vestibular nucleus
   b. Oculomotor nucleus
   c. Abducent nucleus
   d. Trochlear nucleus

95. **Left sided lateral gaze is affected in lesion of –** *(Recent pattern 2014)*
   a. Right frontal lobe b. Right occipital lobe
   c. Left occipital lobe d. Left frontal lobe

96. **A patient presents with Diplopia with limitations of adduction in the left eye and abducting saccade in the right eye. Convergence is preserved. Most likely etiology is** *(AIIMS May 2009)*
   a. Partial 3rd nerve palsy
   b. Internuclear ophthalmoplegia
   c. Duane's retraction syndrome
   d. Absence of medial rectus muscle

97. **One and a half syndrome is due to lesion in:** *(JIPMER 2011)*
   a. Parapontine reticular formation (PPRF)
   b. Medial longitudinal fasciculus (MLF)
   c. Both PPRF and MLF
   d. Occipital lobe

98. **Increased Left Internuclear Ophthalmoplegia is seen as** *(NIMHANS 2016)*
   a. Impaired adduction and nystagmus of left
   b. Impaired adduction and nystagmus in right eye
   c. Impaired adduction of right eye and nystagmus in left eye
   d. Impaired adduction of left eye and horizontal nystagmus of Right eye

Miscellaneous

99. **True about A-V pattern heterotropia squint:** *(PGI May 2015)*
   a. The terms 'A' or 'V' pattern squint are labeled when the amount of deviation in squinting eye varies by more than 10° and 15°, respectively, between upward and downward gaze.
   b. The terms 'A' or 'V' pattern squint are labeled when the amount of deviation in squinting eye varies by more than 20° and 25°, respectively, between upward and downward gaze.
   c. Usually, overaction of the inferior oblique or weakness of superior oblique leads to a A pattern & overaction of the superior oblique or weakness of inferior oblique to an V pattern
   d. Usually, overaction of the inferior oblique or weakness of superior oblique leads to a V pattern & overaction of the superior oblique or weakness of inferior oblique to an A pattern
   e. Oblique muscle dysfunction is the commonest cause of AV pattern

100. **Ophthalmoplegic migraine is best defined by** *(All India 2011)*
   a. Headache with irreversible loss of ophthalmic nerve function
   b. Recurrent transient 3rd nerve palsy associated with headache
   c. Recurrent transient 3rd, 4th and/or 6th nerve palsy associated with headache
   d. Headache associated with optic neuritis

101. **Ice pack test is used for diagnosis of** *(Recent pattern 2013)*
   a. Myasthenia gravis b. Multiple sclerosis
   c. Lambert eaton syndrome
   d. Hyperthyroidism

Most Recent Questions of 2019-2017 are given at the end

A person has restricted eye movements in all directions, ptosis but no squint or diplopia. What is diagnosis *(AIIMS May 2011)*

a. CPEO
b. Multiple cranial nerve palsy
c. Myasthenia gravis
d. Orbital apex syndrome
e. Thyroid myopathy

All of the following drugs increase the risk of postoperative nausea and vomiting after squint surgery in children except *(Recent pattern 2105)*

a. Halothane
b. Opioids
c. Propofol
d. Nitrous oxide

***Parasitosis of extraocular eye muscles* is seen in** *(Recent pattern 2015)*

a. Trichinosis
b. Cysticercosis
c. Amoebiasis
d. Ascariasis

In ophthalmology, *muscle resection leads to* *(Recent pattern 2016)*

a. Weakening of muscle
b. Strengthening of muscle
c. Muscle paralysis
d. No effect

A newborn has strabismus. Which of the following is the rationale for surgically correcting this problem during early childhood?

a. Cataract formation is more likely in misaligned eyes
b. Neither eye will develop normal monocular vision
c. Normal binocular vision will not develop
d. Separate representations of each retina will develop on the visual cortex

Lost muscle in squint surgery is

a. MR
b. LR
c. SR
d. SO

All of the following are true about *Botulinum toxin* except

a. Used for chemodenervation
b. Injected into the paralytic muscle
c. Blocks acetylcholine release
d. Used to determine the risk of postoperative diplopia

A 26 years old male with restriction of eye movements in all directions and moderate ptosis but with no Diplopia or squint. Diagnosis is *(AIIMS Nov 2009)*

a. Thyroid ophthalmopathy
b. Chronic progressive external ophthalmoplegia
c. Myasthenia gravis
d. Multiple cranial nerve palsies

110. Ocular bobbing is seen in lesion at level of– *(Recent pattern 2013)*

a. Midbrain
b. Pons
c. Medulla
d. Cortex

111. Down-beat nystagmus is seen in lesion of – *(Recent pattern 2013)*

a. Brainstem
b. Cerebellum
c. Basal ganglia
d. Hippocampus

112. *Illuminated frenzel glasses* are used in detecting– *(Recent pattern 2015)*

a. Nystagmus
b. Heterophoria
c. Esotropia
d. Astigmatism

Most Recent Questions of 2019-2017

113. In dextroversion yoke muscle for Right lateral rectus: *(Recent pattern 2017)*

a. Left lateral rectus
b. Left medial rectus
c. Right medial rectus
d. Right superior oblique

114. All of the following are seen in case of occulomotor nerve palsy except *(AIIMS May 2018)*

a. Ptosis
b. Pupillary dilatation
c. Superior and lateral position eyeball
d. Light reflex absent

115. Which of the following is the function of Superior rectus muscle *(Recent pattern 2017)*

a. Intorsion, Adduction and Elevation
b. Intorsion, Abduction and Depression
c. Extorsion, Adduction and Elevation
d. Extorsion, Abduction and Elevation

116. All of the following are true about Superior oblique palsy except *(PGI May 2018)*

a. Hypotropia on the same side
b. Excyclotorsion
c. Head tilt to the opposite side
d. Chin elevation
e. Blepharoptosis of eyelid

117. Esotropia is associated with *(Recent question Jan 2019)*

a. Myopia
b. Hypermetropia
c. Astigmatism
d. Presbyopia

Most Recent Questions of 2019-2017 are given at the end

ANSWERS TO IMAGE-BASED QUESTIONS

1. Ans. (c) Right exotropia

Ref: Kanski 7/e, p. 755

2. Ans. (b) Hirschberg's Corneal reflex test

Ref: Kanski 7/e, p. 755

In the above photograph, you can see the corneal reflex shinning in both the eyes of the child, and thus the most likely answer is Hirschberg's corneal reflex test.

3. Ans. (d) 30 prism diopter

Ref: Kanski 7/e, p. 755

- If corneal reflex visible at pupillary margin (as in image)–15 degree or 30 prism diopter of squint.

4. Ans. (b) Nystagmus blockage syndrome; (d) Right Internuclear ophthalmoplegia

Option a – The child maybe a myopic and spectacle correction can control the deviation by stimulating accommodation and with it convergence.

Option b – NBS is associated with esotropia

(Nystagmus is present when the eyes are straight and it disappears when the eyes are locked into esotropia)

Option c – In DRS type II, abduction is normal but adduction is limited, and thus the patient may have slight Exodeviation.

Option d – Right INO will cause Left gaze defect, and limitation of Adduction of right eye, but no deviation.

5. Ans. (c) Left esotropia – Essential infantile esotropia

6. Ans. (c) Convergence insufficiency

Will lead to divergence tendency or exophoria

7. Ans. (b) Prism Bar cover test

Ref: Parson's 22/e, p. 421

The best and the simplest test is the Prism bar cover test (PBCT).

8. Ans. (a) DRS I

Option a - Limitation of abduction with minimal limitation of adduction due to resistance with retraction are features of DRS-I syndrome.

Option b – Limitation of adduction only with retraction.

Option c – Limited abduction and adduction with retraction.

Option d – limitation of elevation on adduction.

9. Ans. (d) Worth four dot test

Ref: Kanski 7/e, p. 751

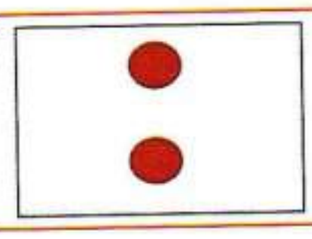
10. Ans. (c) Binocular vision

Ref: Kanski 7/e, p. 750

11. Ans. (a) Anomalous retinal correspondence without manifest squint

Anomalous retinal correspondence is a sensory adaptation to squint – and occurs only if squint is manifested (small angle squint)

12. Ans. (b)



Ref: Kanski 7/e, p. 751

Loss of vision in left eye due to squint (45°) induced due to trauma – would lead to confusion and hence may cause Amblyopia due to suppression – so only 2 red dots visible, as red glass infront of right eye.

13. Ans. (a) It is the most physiological test for Binocular single vision

Ref: Kanski 7/e, p. 751

14. Ans. (c) Superior oblique

Ref: Kanski 7/e, p. 738

The SO muscle originates from the Orbital apex – reaches and passes through the trochlea – turns posterolaterally to insert into the sclera.

(The turning of the muscle at the supero-medial angle is the key to identifying the muscle)

15. Ans. (b) 1,3,5

Ref: Parson's, 20/e, p. 382

Uniocular eye movements (ductions)

Movement	Main muscle	Other muscles
Abduction	Lateral rectus (3)	Superior oblique (1) Inferior oblique (5) (Both muscles are inserted behind the centre of rotation and pull the posterior pole of the globe medially when they contract and hence the anterior portion of the eye is abducted
Adduction	Medial rectus	Superior rectus Inferior rectus (Both muscles are inserted anterior to the centre of rotation and pull the anterior portion of the globe medially in adduction)
Elevation	Superior rectus in abduction Inferior oblique in adduction Both in primary position	
Depression	Inferior rectus in abduction Superior oblique in adduction Both in primary position	
Intorsion	Superior oblique	Superior rectus
Extortion	Inferior oblique	Inferior rectus

16. Ans. (c) Dextrodepression

Ref: Parson's 22/e, p. 407

First, you have to identify the muscle as **SO**, then the eye as **LEFT** (based on the direction of the SO tendon and the position of trochlea being medial)

The primary function of SO is depression which is more during adduction, thus the **LSO**, moves the left eye downward and medially (toward the right side), thus, Dextrodepression.

17. Ans. (d) 5

Ref: Parson's 22/e, p. 404

The four recti and SO originate from the Orbital apex. Only **inferior oblique (5)**, does not originate from the apex.

18. Ans. (a) 6

Ref: Grays anatomy, 41/e, p. 671

19. Ans. (b) Inferior division of the Oculomotor nerve

Ref: Grays anatomy students handbook, p. 888

4 = inferior rectus

20. Ans. (c) Entoptic phenomenon

Option a – Red green goggles are used for diplopia charting by dissociating the 2 eyes

Option b/d – used as part of Worth Four Dot Test, to differentiate between sensory anomalies

21. Ans. (d) Maddox rod test

Ref: Parson's, 22/e, p. 423

Red colored striated lenses

22. Ans. (c) It can differentiate between a phoria and tropia

Ref: Parson's, 22/e, p. 423, 276

Option a – to measure horizontal deviations, Maddox rod axes are placed horizontal and the rods cause the streak of light to be an angle of 90 degree, thus creating a vertical streak.

To measure vertical deviations, axes are placed vertical, producing a horizontal streak.

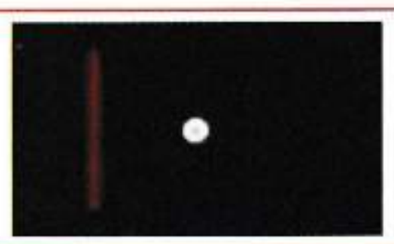
Option b – used for Macular function test in cases of Opaque media

- Patient is asked to fixate light at a distance of 33 cm through the Maddox rod, with the other eye occluded.
- Any breaks, holes, discoloration, distortion in red line indicates macular lesion.

Option c – it cannot differentiate, it is primarily used to diagnose a case of phoria

Option d – the rod placed in front of one of the eye dissociates the two eyes because the red streak cannot be fused with the white spot of light seen from the other eye.

23. Ans. (b)



Ref: Parson, 22/e, p. 423

On Maddox rod test in the above patient with the Maddox rod infront of the right eye, 3 results are possible

Option a – if the vertical streak of light passes through the centre of the spot of light, it indicates Orthophoria

Option b – if the vertical streak of light appears to the left of the spot light, it indicates Exophoria (crossed diplopia), as the Maddox rod is placed in front of the right eye in the photograph.

Option c – if the vertical streak of light appears to the right of the spot light, it indicates Esophoria (uncrossed diplopia)

24. Ans. (d) Maddox rod test

Ref: Parson's, 22/e, p. 423

25. Ans. (b) Diagnose cyclotropia

Option b - Two Maddox rods, one red and the other white, are placed in front of the two eyes with the axes vertically. A 4 Diopter base-down prism is placed in front of one of the rods to displace one of the lines upwards.

A patient without any cyclotropia will see two parallel lines one above the other.

Patient with cyclotropia will see one horizontal line and one tilted line. He is then instructed to rotate the Maddox rod corresponding to the tilted line such that the two lines become parallel to each other. The axis of this rod gives the degree of cyclo-deviation.

Use: In cases of 4th nerve palsy, unilateral cases have less than 10 degree of cyclodeviation, whereas bilateral cases have greater than 10 degree.

26. Ans. (b) Maddox rod

Ref: Parson's 22/e, p. 423; Parson's 21/e, p. 413-414

Cylindrical red glass in a supporting disc in a trial frame – Maddox rod

Disc of deeply grooved glass – hand held – Maddox groove

Essentially both are the same instruments, just a nomenclature difference

27. Ans. (d) Oculomotor nerve paralysis

Ref: Kanski, 7/e, p. 832

- In the above photograph, Ptosis is seen, but it is not sufficient to comment on the other signs of Horner's syndrome
- Oculomotor (IIIrd cranial) nerve paralysis
- Ptosis
- Down and out eye (Depression due to action of superior oblique and abduction due to action of lateral rectus)

28. Ans. (a) Foville syndrome

Ref: Kanski, 7/e, p. 836-838

Option b/c - Intracavernous causes of 3rd nerve palsy

- Diabetes
- Pituitary apoplexy
- Tolosa-Hunt syndrome
- Aneurysm
- Meningitis

Intracavernous III nerve palsies are associated with the involvement of the VI and VI nerves and the first division of the V nerve.

Option d - Weber's Syndrome leads to fasicular III nerve palsy.

Option a - Foville syndrome –characterized by ipsilateral involvement of V to VIII nerves.

29. Ans. (b) Primary deviation = secondary deviation

Ref: Parson's, 22/e, p. 416

In paralytic squint (Incomitant), primary deviation < secondary squint

30. Ans. (b) Trauma

Ref: Kanski, 7/e, p. 832

Option a/c/d – Causes of Isolated pupillary paralysis in oculomotor nerve palsy

- Botulism
- Diphtheria
- Uncal herniation
- Basal meningitis

These conditions have accomodational (ciliary muscle) and pupillary (sphinctre papillae muscle) paresis, without involvement of the extraocular muscles.

Thus, in the above patient, the cause will be Trauma.

31. Ans. (d) It is a case of nuclear 3rd nerve palsy

In a case of Nuclear palsy, Ptosis will be bilateral always, as there is an unpaired subnuclei for both the LPS. Mydriasis is also bilateral due to the same reason.

32. Ans. (a) Left lateral rectus palsy

Only, left eye ABDUCTION is paralyzed.

33. Ans. (a) Epicanthus

Ref: Parson's, 22/e, p. 482

Semilunar fold of skin cover the inner canthus of both eyes (bilateral), thus, giving the appearance that both eyes have convergent squint and the bridge of nose is flat.

34. Ans. (c) Pseudoesotropia

Ref: Parson's, 22/e, p. 430

35. Ans. (d) RSR & LIO

Ref: Kanski, 7/e, p. 740

In the image seen – both eyes are looking upward and to the right side

↓

thus, Right eye – Elevation in ABduction – function (clinical) of RSR

and Left eye – Elevation in ADduction – function (clinical) of LIO

36. Ans. (a) Dextrolelevation – Tertiary gaze

Ref: Kanski, 7/e, p. 740

In the image both eyes going up and right – known as Dextroelevation – Tertiary position of gaze.

37. Ans. (b) Internuclear ophthalmoplegia > (a) Horizontal gaze palsy

Ref: Kanski 7/e, p. 839; Parson's, 22/e, p. 539

Option a – in horizontal gaze palsy, due to PPRF lesion, both Adduction and Abduction will be lost.

Option b – Lesion of right MLF, which controls the right eye ADduction, for movement in right lateral gaze – a type of horizontal gaze palsy known as Internuclear ophthalmoplegia.

Option c – paralysis of sphincter pupillae and ciliary muscle.

Option d – restrictive squint with retraction of globe and closure of palpebral fissure.

38. Ans. (b) Esophoria

Ref: Pradeep's Strabismus, 2/e, p. 73

On cover test – no movement of the uncovered eye is seen – thus, no tropia.

On uncover test, right eye is seen to move outward (look at the arrow), indicating an inward deviation of the eye behind the cover due to breakage of fusion.

Thus it is a case of EsoPhoria – Inward deviation (induced by breaking fusion) visible as eye moving out on uncover test.

39. Ans. (b) Heterophoria

Cover-Uncover test is being done in the image. It can be used to differentiate between Phoria and tropia.

40. Ans. (b) Myasthenia gravis

Ref: Kanski 7/e, p. 850-852; Parson's, 22/e, p. 477

Option a – 6th nerve palsy presents with esotropia. There is no ptosis

Option c – 3rd nerve palsy presents with down and out eye with ptosis and mydriasis, but there is no drug which can temporarily treat the condition

Option d – The diagnostic criteria for **Tolosa-Hunt syndrome** is as follows:

- One or more episodes of unilateral orbital pain persisting for weeks if untreated.
- Paresis of one or more of the third, fourth and/or sixth cranial nerves and/or demonstration of cavernous sinus granuloma by MRI or biopsy.
- Paresis coincides with the onset of pain or follows it within 2 weeks.
- Pain and **paresis resolve within 72 hours when treated adequately with corticosteroids**.
- Other causes have been excluded by appropriate investigations

Option b – Myasthenia Gravis can be confirmed by **Edrophonium test**

Edrophonium is a short acting anticholinestrase agent which increases the acetylcholine levels in the post synaptic cleft, resulting in transient improvement in signs and symptoms (ptosis and diplopia)

Baseline measurements recorded with a Hess chart (for diplopia)

↓

I.V. atropine (0.3 mg) given to antagonize the muscarinic side effects

↓

I.V. edrophonium (0.2 mg) given

↓ ↓

If improvement, test terminated

I.V. edrophonium (0.8 mg) given after 60 seconds

↓ ↓

Within 5 minutes, final Hess chart measurements are done to document the clinical improvement

42. Ans. (c) 6th nerve palsy

Ref: Kanski 7/e, p. 838; Parson's, 22/e, p. 453

In Straight **(Primary) gaze** - left eye Esotropia (inward deviation)

In **Right gaze** – both eyes move towards right side, thus, RLR and LMR functioning normally

In **Left Gaze** – Right adduction present – RMR functioning but left eye does not Abduct – LLR not functioning

Thus, patient presenting with esotropia of left with paresis of left gaze, thus LLR palsy, supplied by 6th cranial nerve

43. Ans. (a) 3rd cranial nerve palsy

(Ref: Kanski 7/e, p. 832,833; Parson's 22/e, p. 444)

This is an image showing 9 cardinal gaze positions
In Primary Gaze (center most image) – Left eye ptosis, hence LPS palsy and slight hypotropia with exotropia may be seen (if you focus on the corneal reflex which is seen above and nasal to the center of pupil)
In right Gaze (Dextro) – Left eye Adduction is absent, hence MR palsy
In upgaze – left eyelid is not able to retract and the eyeball doesnot elevate, thus, confirming the case of 3rd cranial nerve palsy

44. Ans. (a) Cover test

Ref: Parson's 22/e, p. 420

40. Ans. (a) Superior colliculus

Ref: Kanski 7/e, p. 830

ANSWERS TO MULTIPLE CHOICE QUESTIONS

45. Ans. (a) Superior branch of Oculomotor nerve

Ref: Kanski 7/e, p. 831

46. Ans. (b) Intorsion; (e) Depression

Ref: Khurana 6/e, p. 336-39; BDC 6/e, p. 211

47. Ans. (a) (Insertion...) & (d) (Attached...)

Ref: Khurana 4/e, p. 313; BDC 4/e, Vol. III p. 109

Table (BDC 4/e, Vol. III, p. 109) : Action of individual muscles

Muscle	In primary position	Abducted eye	Adducted eye
Superior oblique	Depression Abduction Intorsion	Only intorsion	Only depression
Inferior oblique	Elevation Abduction Extortion	Only extortion	Only elevation
Inferior rectus	Depression Adduction Extortion	Only depression	Only extortion
Superior rectus	Elevation Adduction Intorsion	Only elevation	Only intorsion
Medial rectus	Only adduction	—	—
Lateral rectus	Only abduction	—	—

48. Ans. (b) Extorsion

Ref: Kanski 8/e, p. 730

49. Ans. (c) SO

Ref: Parson's, 22/e, p. 404

50. Ans. (b) 5.5 mm

Ref: Parson's, 22/e, p. 403

Medical rectus is closest muscle to the limbus.

51. Ans. (b) Elevation, adduction, intorsion

Ref: Yanoff and Duker 4/e, p. 1183

52. Ans. (c) It originates from the annulus of Zinn

Ref: Yanoff and Duker 4/e, p. 1183

53. Ans. (c) Down and in

Ref: Neeta Kulkarni p. 403, Kanski 7/e, p. 738

"The clinical test for strongest action of the superior oblique is to ask the patient to look in (medially) and then down" – At the tip of nose

54. Ans. (a) Sherrington's law

Ref: Parson's, 22/e, p. 408

55. Ans. (c) Right inferior oblique

Ref: Khurana Anatomy, 2/e, p. 299

56. Ans. (b) Right superior rectus and left inferior oblique

Ref: Kanski 7/e, p. 740; Parson's, 22/e, p. 407

57. Ans. (d) Right inferior rectus and Left inferior oblique

Ref: Kanski 8/e, p. 733, Khurana Anatomy 2/e, p. 299

58. Ans. (b) Rt MR and Lt LR

Ref: Parson's 22/e, p. 407

59. Ans. (a) Superior rectus

Ref: Parson's, 22/e, p. 408

Innervation of superior rectus is contralateral, rest all recti have ipsilateral innervation.

60. Ans. (c) Interstitial nucleus of cajal

Ref: Yanoff 4/e, p. 916

The rostral interstitial nucleus of the medial longitudinal fasiculus (**riMLF**) contains neurons for both upward and downward saccades. Their axons relay to neurons in the **interstitial nucleus of cajal**, which discharge in relation to vertical eye position and play a part in pursuit movements.

Neurons for upward saccades innervate both ipsilateral and contralateral nucleus of occulomotor and trochlear nerve, but only ipsilateral for downgaze.

61. Ans. (d) Demyelinating disease

Diplopia on looking to the right side suggests either 6th cranial nerve paresis or Internuclear ophthalmoplegia due to MLF lesion (but blurring of vision shouldnot be associated with INO)

Cranial neuritis – implies multiple cranial neuropathy, can be seen in cases of Lyme disease

Chronic meningitis – duration of symptoms is acute, and no signs of neck rigidity

Demyelinating disease – Multiple sclerosis can present with ill defined symptoms of malaise, blurring of vision due to associated optic neuritis and diplopia due to either cranial nerve involvement or it can itself cause internuclear ophthalmoplegia

62. Ans. (a) Unilateral lesion result in adduction palsy of opposite eye

Ref: Kanski 7/e, p. 839

MLF lesion leads to contralateral gaze defect with ipsilateral adduction defect.

It helps in horizontal gaze, that is both eyes moving towards right or left, Conjugate or version movement

63. Ans. (b) Binocular single vision

Ref: Kanski 7/e, p. 750-751

It is a dissociation test which is used for both near and far distance and differentiates between BSV, ARC, suppression.

64. Ans. (a) 2 green, 1 red, 1 white

Ref: Kanski 7/e, p. 750

65. Ans. (c) 36 cm

Ref: Parson's, 22/e, p. 45

A prism dioptre is defined as the amount of deviation of light by the prism measured at 100cm.

Thus, in the patient for every 100cm/1m, light is deviated by 6cm.

At 6m, 6(pd) x 6(m) = 36 cm

66. Ans. (b) Bagolini striated glasses

Ref: Kanski 7/e, p. 751

- Most physiological and least dissociating test – Bagolini striated glasses test
- Least physiological and most dissociating test – After image test

67. Ans. (b) Prism

Ref: Parson's, 22/e, p. 421

2Δ (Prism) deviation is equal to 1° (degree).

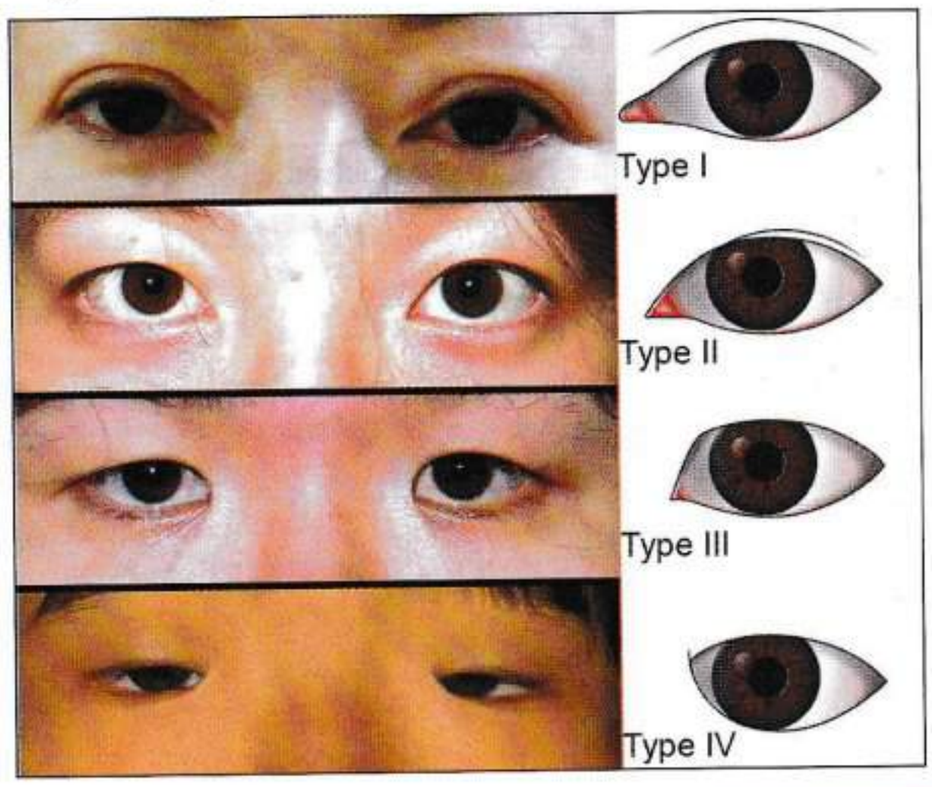
68. Ans. (a) Pseudostrabismus

Ref: Nelson Part 1/p. 1755, Pradeep Sharma's Strabismus 2/e, p. 71

- Epicanthal fold causes pseudoesotropia (Pseudostrabismus); by covering the medial canthus of eye and **making eyes appear crossed and moved inwards.**

Types of Epicanthus

Type 1 – Palpebralis – downslant
Type 2 – Tarsalis
Type 3 – Inversus – upslant
Type 4 – Superciliaris



69. Ans. (a) Retinopathy of prematurity

Ref: Pradeep Sharma, 2/e, p. 71

70. Ans. (a) Constant amount of deviation in all directions of gaze

Ref: Pradeep sharma 2/e, p. 122; Parson's, 22/e, p. 416

71. Ans. (c) Primary deviation = Secondary deviation

Ref: Parson's, 22/e, p. 416

72. Ans. (a) Amblyopia..., (b) Angle of deviation..., (e) May be associated....

Ref: Parson 22/e, p. 428-29; Kanski 7/e, p. 766

- **Time of surgery:** Surgery should be *done b/w 6 months to 2 years* (preferably before 1 yr of age)

Ans. (b) Convergent squint

Ref: Parson's, 22/e, p. 425

Ans. (b) Onset from infancy to 4 years of age

Ref: Kanski 7/e, p. 768-769

Option a – feature of Essential infantile esotropia.

Option b – most neonates are not accommodating, so the esotropia is acquired when the infant starts to accommodate to bring near objects to focus.

As a result of Hypermetropia (2-3 D at birth) in the child, additional accommodative effort is required to bring the images into focus, and thus over convergence response is seen (Near reflex has 3 parts: Accommodation, convergence and miosis).

Option c – accommodative esotropia(s) are usually hypermetropic, but rarely more than 7.00 D.

If more than that, both eyes become amblyopic without correction.

Option d – the binocular potential is normal. Accommodative esotropia is due to an exaggerated near reflex.

Ans. (b) Infantile esotropia

Ref: Pradeep Sharma, Strabismus 2/e, p. 91; Handbook of pediatric strabismus & amblyopia 2/e, p. 221

- Dissociated vertical deviation (**DVD**) develops in 80% cases by age of 3 years – **updrift with excyclotorsion of the affected eye under cover.**

Ans. (b) Refractive accommodative esotropia

Ref: Kanski 7/e, p. 768

Normal AC/A ratio with esotropia in a hypermetropia child indicates overaccommodation leading to excessive convergence. Thus, refractive accommodative esotropia.

Ans. (a) Abnormal head posture

Ref: Pradeep Sharma 2/e, p. 122

Ans. (a) Miosis

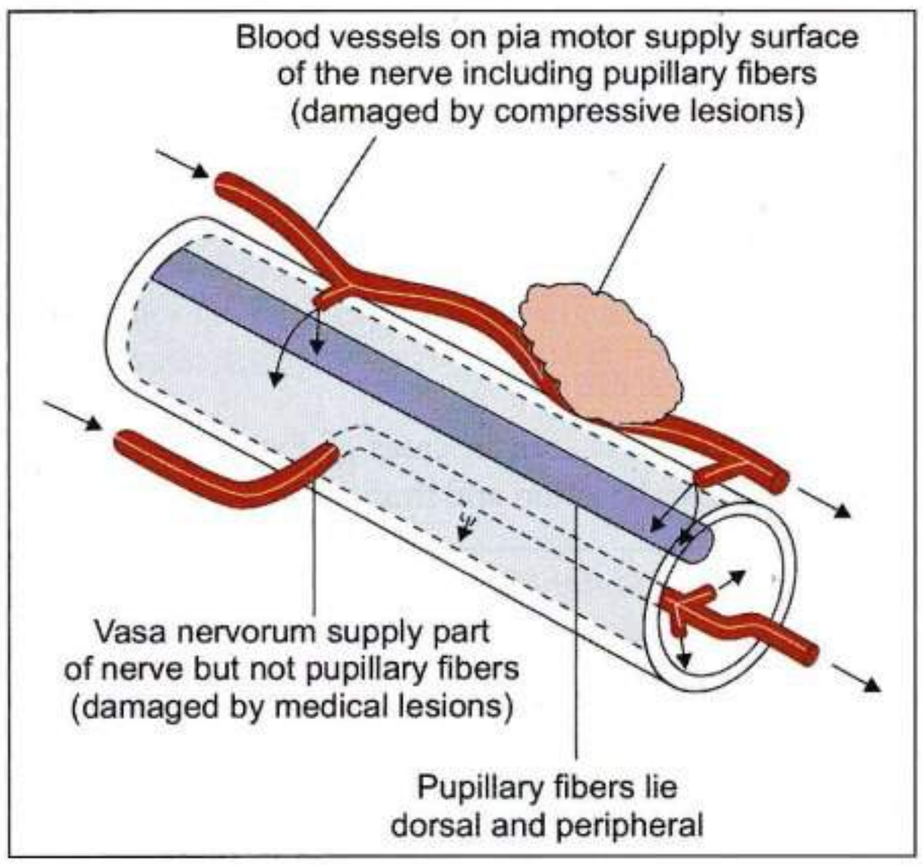
Ref: Parson's 21/e, p 432

- Oculomotor nerve supplies the sphincter pupillae muscle and thus its palsy causes overaction of dilator pupillae causing mydriasis.

Ans. (d) Diabetes Mellitus

Ref: Kanski 7/e, p. 832

'Medical' **vascular lesions** such as hypertension and diabetes usually spare the pupil. **This is because the microangiopathy associated with medical lesions involves the vasa nervorum, causing ischemia of the main trunk of the nerve, sparing the superficial pupillary fibers.**


Blood vessels on pia motor supply surface of the nerve including pupillary fibers (damaged by compressive lesions)
Vasa nervorum supply part of nerve but not pupillary fibers (damaged by medical lesions)
Pupillary fibers lie dorsal and peripheral

80. Ans. (b) 3rd cranial nerve palsy

Ref: Nema 3/e, p. 610

81. Ans. (b) Oculomotor nerve

Ref: Kanski 7/e, p. 781

All adductors are paralyzed, SO_4, and LR_6 which are not paralyzed both abduct the eye.

82. Ans. (c) Enters orbit through the inferior orbital fissure

Ref: Parson's, 22/e, p. 408

83. Ans. (c) 3rd nerve palsy

Ref: Liu, Neuro-ophthalmology diagnosis and management 2/e, p. 570) (Adler's, Physiology of eye, 11/e, p. 203

Nothnagel syndrome involves superior fasciculus and superior cerebellar peduncle characterized by 3rd nerve palsy, cerebellar Ataxia.

84. Ans. (a) Vertical on looking down

Ref: Understanding Neurology: A problem-Oriented Approach' by Greens, Bone (Manson Publishing) 2007/121

'Trochlear nerve palsy (Superior oblique nerve palsy) causes vertical diplopia maximal on downward gaze such as while attempting to climb downstairs or while reading which makes the eye look down while adducted'.

85. Ans. (b) 4th cranial nerve

Ref: Kanski 7/e, p. 832

86. Ans. (b) Right head tilt

Ref: Kanski 7/e, p. 832

87. Ans. (a) Left superior oblique

Ref: Parson's, 22/e, p. 441

88. Ans. (b) Right lateral rectus paralysis

Ref: Kanski 7/e, p. 835

89. Ans. (a) MR

Ref: Nema 3/e, p. 610

Crossed diplopia is seen in cases of Exodeviation. MR palsy will lead to Exodeviation and thus crossed diplopia.

Causes of Uniocular Diplopia

- Subluxated lens
- Keratoconus
- Double pupil e.g. Iridodialysis, ICE syndrome
- Incipient cataract

Causes of Binocular Diplopia

- Paralytic squint
- Myasthenia gravis
- Diabetes Mellitus
- Thyroid d/s
- Blow out fractures

90. Ans. (a) Head turn to the right side

Ref: Kanski, 7/e, p. 837

91. Ans. (d) Diplopia in left gaze

Ref: Parson's, 22/e, p. 440

Diplopia in direction of action of muscle LLR moves left eye towards left side (AB duction), thus diplopia in left gaze.

92. Ans. (c) Duane's Retraction syndrome type 3

Ref: Pradeep sharma, strabismus simplified 2/e, p. 150

Refer text

93. Ans. (d) Forced duction test

Ref: Parson's 20/e, p. 385, Pradeep Sharma 2/e, p. 80

Option a – Doll's head movements generated by gentle, but rapid, turning of the baby's head can induce abduction past midline.

Option b – the generation of a good saccadic abduction on OKN drum can also indicate a well functioning LR. If an eye is in adduction due to palsy, there would not be enough LR function to generate a normal saccade.

Option c – by patching one eye the patient will have to abduct in order to see the temporal field of vision.

Option d – FDT is positive in cases of restrictive conditions of incomitant squint.

94. Ans. (c) Abducent nucleus

Ref: Atlas of Neuroophthalmology by Spoor (2004) p. 204

'The PPRF is the final common pathway for horizontal gaze. It is intimately related to the sixth nerve nucleus'

95. Ans. (a) Right frontal lobe

Ref: Brainstem disorders by Peter Urban 2/e, p. 106

- **If horizontal gaze** is affected, the damage may be:–
  - **Cortical center:** Contralateral frontal eye field.
  - **Brainstem center**: I/L Pons (Pontine paramedian reticular formation).
  - **Cranial nerve nucleus**: I/L Abducens (6th nerve) nucleus.

96. Ans. (b) Internuclear ophthalmoplegia

Ref: Kanski, 7/e, p. 839

97. Ans. (c) Both PPRF and MLF

Ref: Yanoff and Duker 4/e, p. 919

98. Ans. (d) Impaired adduction of left eye and horizontal nystagmus of Right eye

Ref: Harrison 19/e, p 209

99. Ans:. (a) The terms 'A' or 'V' pattern…; (d) Usually….; (e) Obliqu….

Ref: Parson 22/e, p. 427-29; Pradeep strabismus 2/e, p. 110-114

100. Ans. (c) Recurrent transient 3rd, 4th and/or 6th nerve palsy associated with headache

Ref: The headaches by Olesen (Lippincott Williams and Wilkins) 3/e, p. 1049

IHS diagnostic criteria for ophthalmoplegic membrane (ICHD-II)

- At least two attacks fulfiling criterion B
- ***Migraine like headache accompanied or followed within 4 days of its onset by paresis of one or more of the third, fourth, and/or sixth cranial nerves***
- Parasellar, orbital fissure, and posterior fossa lesions ruled out by appropriate investigations.

101. Ans. (a) Myasthenia gravis

Ref: Kanski 7/e, p. 850

102. Ans. (a) CPEO

Ref: Kanski 7/e, p. 850; Walsh and Hoyt neurophysiology, p. 990

- **(CPEO)** refers to a group of disorders characterized by bilateral ***ptosis*** [Q] ***(first sign)***, bilateral External **ophthalmoplegia**. ***Diplopia is rare***
- Thyroid myopathy *Ptosis is not seen*[Q], *instead there is lid retraction.*
- In **myasthenia gravis**, ocular involvement occurs in 90% of cases and is the presenting feature in 60%. ***Two-thirds of patients have both ptosis and diplopia***[Q].
  Less than 10% of patients have ptosis alone and less than 30% of the patients have diplopia alone.
- **Orbital Apex Syndrome** presents with unilateral ptosis, proptosis, visual loss, internal and external ophthalmoplegia and (forehead) anaesthesia.

103. Ans. (c) Propofol

Ref: Curr Drug Saf. 2010 Apr; 5(2): 132–48. Clinical management of postoperative vomiting after strabismus surgery in children. Fujii Y[1]

104. Ans. (a) Trichinosis

Ref: Walsh and Hoyt's Clinical Neuro-ophthalmology Volume 3, pg 2904; Parson's 22/e, p. 490-491

Correlate Box

- Trichinosis is caused by Trichinella spiralis (Nematode, Helminth)
- Occurs due to ingestion of raw/uncooked pork
- **Ocular Signs**
  Occur in second phase due to invasion of skeletal muscle by larvae
  - Chemosis-Bilateral
  - Periorbital edema
  - Ophthalmoplegia-Due to invasion and enlargement of extraocular muscles
  - Proptosis
  - Choroidal retinopathy with retinal hemorrhages

105. Ans. (b) Strengthening of muscle

Ref: Kanski 8/e, p. 769

Weakening procedures on recti muscle	Strengthening procedures
Recession	Resection[Q]
Pars equatorial myopexy (FADEN)	Advancement
Marginal myotomy	Double breasting or tucking
Myectomy	Cinching
Free tenotomy or disinsertion	Transposition

106. Ans. (c) Normal binocular vision will not develop

Ref: Pradeep Sharma Strabismus, 2/e, p. 93

If the baby has strabismus and it isn't treated, his brain could start ignoring the input from one of his eyes, eventually causing the vision in the ignored eye to deteriorate. This condition is known as amblyopia or "lazy eye". Depth perception could also be damaged.

107. Ans. (a) MR

Ref: www.cybersight.org, www.eyewiki.aao.org, Pubmed, PMID: 11705143)

Lost or slipped muscle is usually MR. It is known as the **Surgeon's Graveyard**.

108. Ans. (b) Injected into the paralytic muscle

Ref: Kanski 7/e, p. 781

Option a – used to create a temporary paralysis of an extra-ocular muscle

Option b – it is **injected into the antagonist muscle**, causing its relaxation, so that the forces on the globe are balanced, thus allowing for assessment of the paralytic muscle

Option c – Botulinum toxin acts by **binding pre-synaptically** to high-affinity recognition sites on the cholinergic nerve terminals and decreasing the release of acetylcholine, causing a neuromuscular blocking effect.

Option d – it is used to assess

- The risk of postoperative diplopia
- The potential for binocular single vision
- In patients with a cosmetically poor deviation

Also used for treatment of

- Blepharospasm – Facial dystonia
- Hemifacial spasm
- To reduce eyelid retraction in thyroid eye d/s
- Induce ptosis in exposure keratopathy
- Chronic dry eye

Side effects

- **Ptosis – transient**
- **Diplopia**
- Dilated pupil
- Scleral perforation
- Reduced accomodation

109. Ans. (b) Chronic progressive external ophthalmoplegia

Ref: Kanski 7/e, p. 852

Restriction of ocular movement in both eyes are symmetrical in chronic progressive external ophthalmoplegia, so there is **no diplopia**.

110. Ans. (b) Pons

Ref: Parson's 22/e, p. 513

Yanoff

111. Ans. (b) Cerebellum

Ref: Parson's 22/e, p. 512

112. Ans. (a) Nystagmus

Ref: Common neuro-ophthalmic pitfalls. Case based teaching by Purvin p. 110

- Illuminated frenzel galsses (+20 lenses) are useful for abolishing fixation and thus revealing peripheral vestibular nystagmus.

113. Ans. (b) Left medial rectus

(Ref: Strabismus Simplified, Pradeep Sharma 2/e, p. 16)

114. Ans. (c) Superior and lateral position eyeball

Ref: Pradeep Sharma 2/e, p. 130-133

Eyeball is Down and out due to paralysis of both elevators (SR and IO) and paralysis of main adductor (MR)

Occulomotor nerve forms the efferent pathway of the Light reflex pathway, thus, Light reflex is lost in 3rd cranial nerve palsy

115. Ans. (a) Intorsion, Adduction and Elevation

Ref: Khurana 6/e, p. 339

116. Ans. (a) Hypotropia on the same side; (d) Chin elevation; (e) Blepharoptosis of eyelid

Ref: Kanski 7/e, p. 834

Hypertropia and chin depression are seen.

117. Ans. (b) Hypermetropia

Ref: Parson's 22/e, p. 416, 425; Kanski 7/e, p. 768

In Refractive accommodative esotropia, the AC/A ratio is abnormal and esotropia is a physiological response to excessive hypermetropia (+2.00 to +7.00 D)

NOTES

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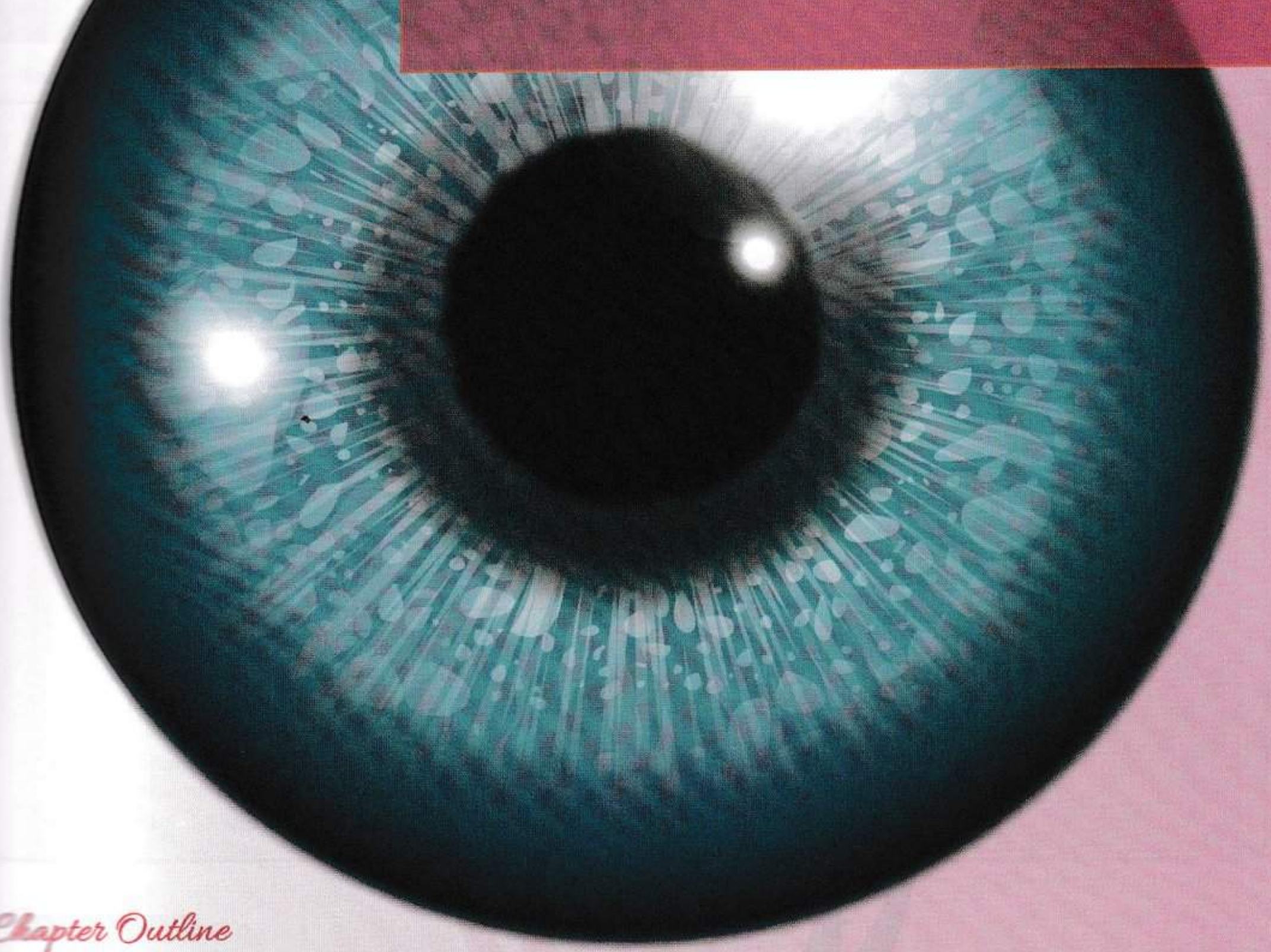
NEURO-OPHTHALMOLOGY



Chapter Outline

Visual Pathway
- Visual Field Defects

Optic Atrophy
- Optic Neuritis
- Hereditary Optic Neuropathy
- Toxic Optic Neuropathy
- Papilledema
- AION

Pupil
- Pupillary Reflexes
- Pupillary Defects
- Horner's Syndrome

Color Blindness

"Learn how to see. Have the nerve. Realize that everything connects to everything else."
—Leonardo da Vinci

VISUAL PATHWAY

Retina–formation of image–akin to film/reel of a camera
Visual cortex–perception of image–akin to the developed photograph

This path of conduction of visual impulses from retina (formation) to the visual cortex (perception) is the visual pathway.

Just like a path/road can have holes, similarly the visual pathway can have lesions which cause visual field defects leading to ANOPIA (blindness)

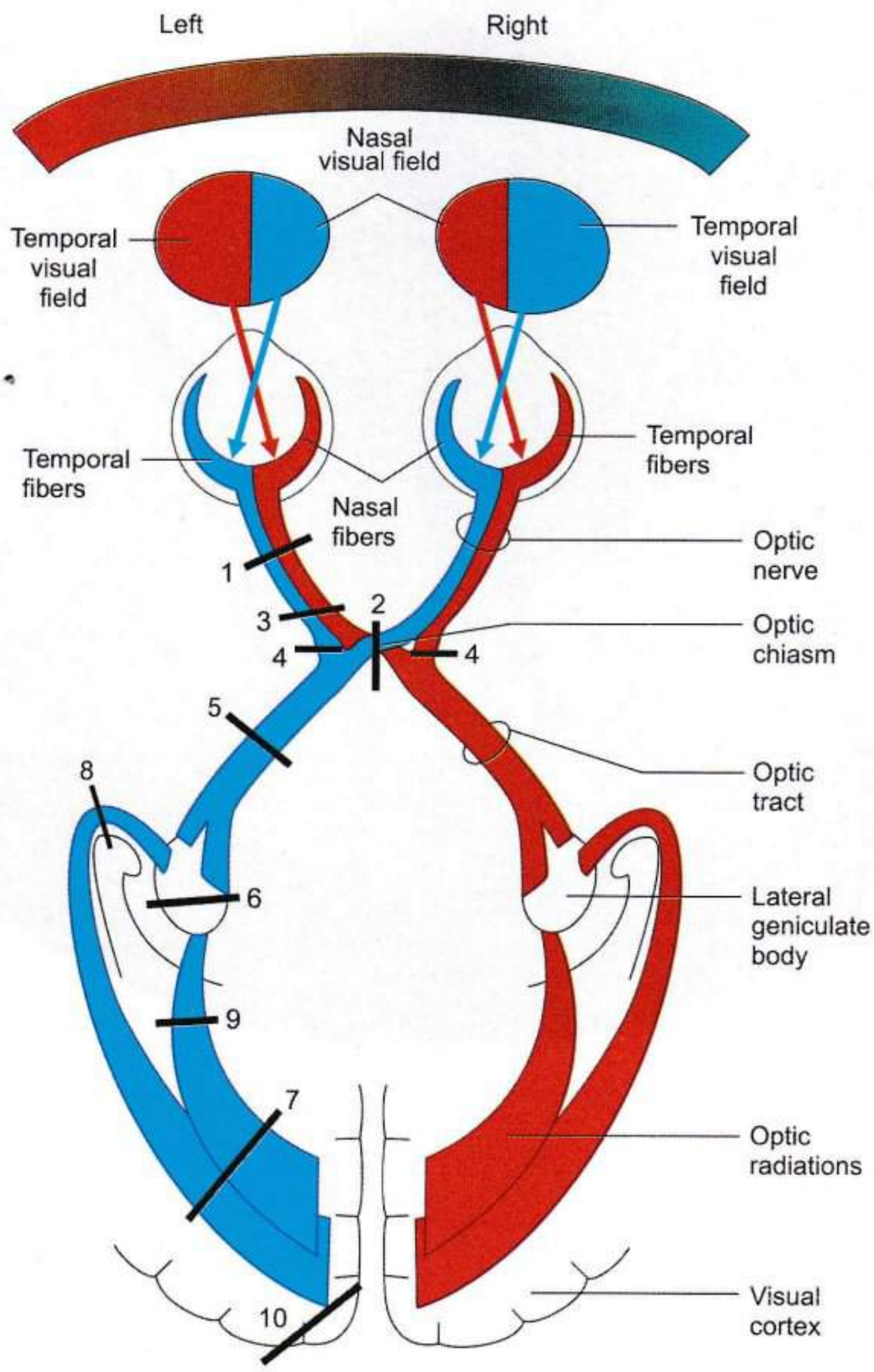
Visual Field Defects

VISUAL FIELD COORDINATES ARE OPPOSITE TO RETINAL COORDINATES

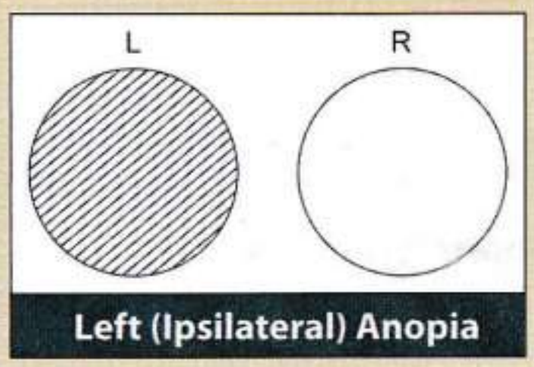
Light from Temporal visual field is projected on the Nasal Retina
Light from Nasal visual field is projected on the Temporal retina.

↓

Thus, **visual field defects will always be opposite to the retinal/visual pathway fibers lost.**



1 Optic Nerve (Left)

Fibers	Visual Field Defect
Left (Ipsilateral) Temporal and nasal	Complete loss of left visual field  **Left (Ipsilateral) Anopia**

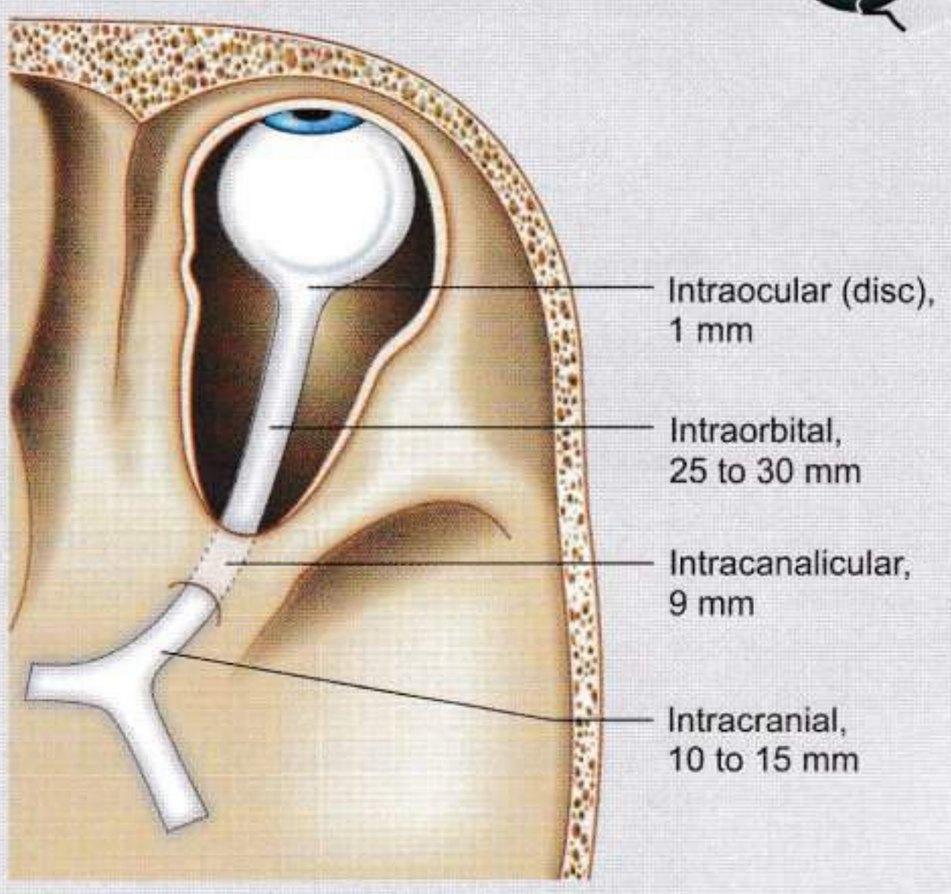
Extra Mile

Macular fibers (centrally located) are the most sensitive to pressure or ischemia, thus, are first damaged. So, **the initial visual field defect, in optic nerve lesion is a Central Scotoma** which progressively involves the whole optic nerve and causes complete blindness—Anopia

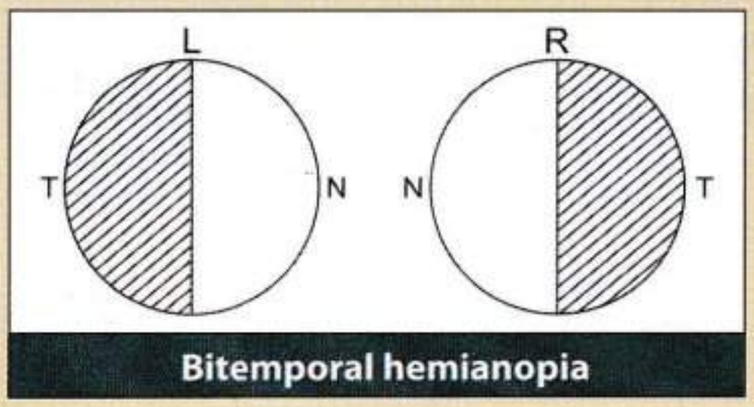
Correlate Box

Anatomy of Optic Nerve

- **Optic nerve** is a backward continuation of the nerve fiber layer of the retina, **composed of axons of retinal ganglion cells**[Q]
- It is not covered by Neurilemma (Schwann cell sheath) - not capable of regeneration
- **Parts of optic nerve** - Total length is 47–50[Q] mm
  - **Intraocular**—visible part of nerve, known as optic disc or optic nerve head (ONH)
    Shortest[Q] part of optic nerve—1 mm[Q], has a diameter of 1.5 mm
  - **Intraorbital**—from the back of sclera to the optic foramen
    - The **longest**[Q] part of optic nerve—30 mm[Q]
    - Diameter increases to 3–4 mm, due to acquisition of myelin sheath by oligodendrocytes
    - Nerve is covered in this part by all 3 meningeal sheaths, i.e. dura, arachnoid and piamater
    - Central retinal artery and vein enter the optic nerve by piercing it **inferomedially**, 10 mm, posterior to eyeball in the intraorbital part.
    - Near optic foramen, some fibers of superior rectus and medial rectus are adherent to the pial sheath, thus on inflammation of optic nerve (Retrobulbar Neuritis), there is Pain on movement of eye[Q]
  - **Intracanalicular**—Within the optic canal, 6–9 mm[Q]. Related to ophthalmic artery which crosses obliquely over it[Q]
  - **Intracranial**—Above cavernous sinus, 10 mm



2 Optic Chiasm

Fibers	Visual Field Defect
Binasal fibers (Decussation of nasal fibers of both optic nerves)	**Bitemporal** visual field loss  **Bitemporal hemianopia**

Causes of Bitemporal Hemianopia

Can be best understood by anatomic relations of optic chiasm

Relation	Structure	Cause
Inferiorly	Pituitary gland in sella turcica	Pituitary, MACRO Adenoma[Q] (>10 mm) Suprasellar extension (Never microadenoma)

EXTRA MILE

Earliest visual field defect seen in cases of Craniopharyngioma

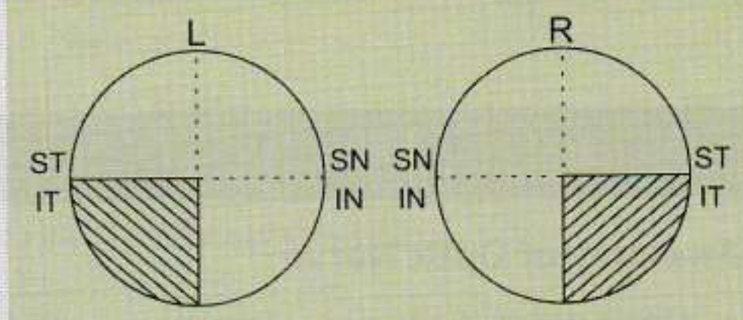
Craniopharyngioma first compresses the Superior binasal fibers

↓

Thus, Lesion of **Binasal Superior** fibers

↓

Bitemporal (**Heteronymous**) Inferior Quadrantanopia



Superiorly	Remnants of Rathke's Pouch	Craniopharyngioma[Q]

EXTRA MILE

Earliest visual field defect seen in cases of Craniopharyngioma

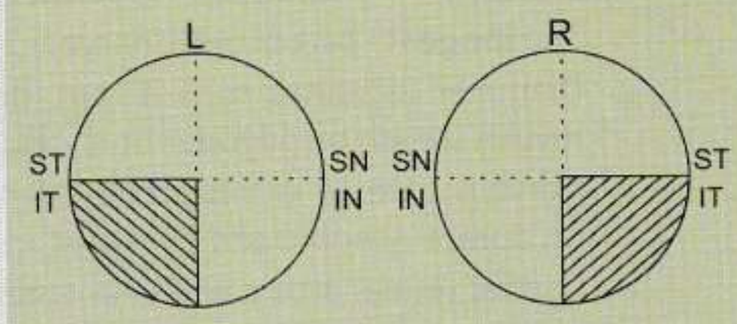
Craniopharyngioma first compresses the Superior binasal fibers

↓

Thus, Lesion of **Binasal Superior** fibers

↓

Bitemporal (**Heteronymous**) Inferior Quadrantanopia



Anteriorly	Anterior cerebral artery	Aneurysm of anterior cerebral artery
Inferolaterally	Cavernous sinus	Aneurysm of cavernous sinus
Superolaterally	3rd ventricle	3rd Ventricular Glioma[Q]

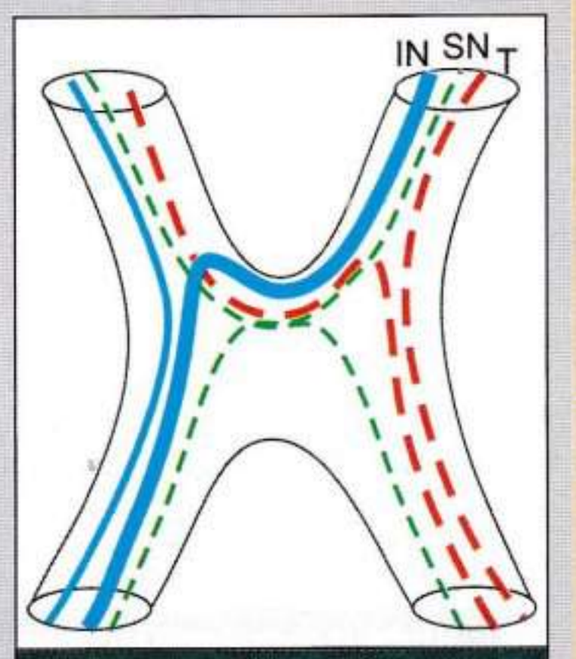
Mnemonic

Causes of Bitemporal Hemianopia → **Buy (Bi) 3 PC & AC**

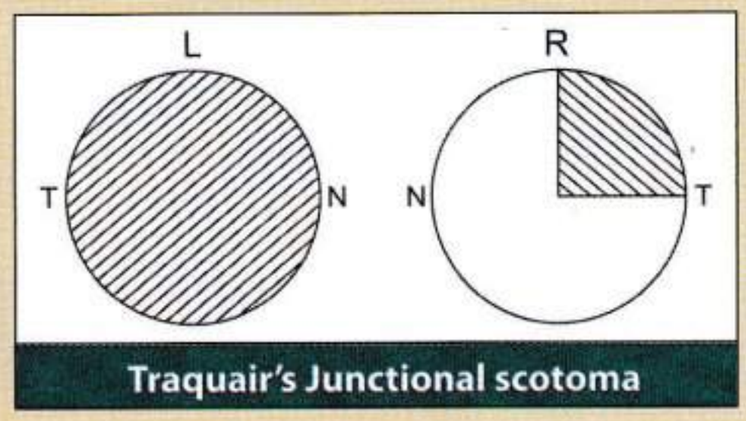
- **Bi** – Bitemporal Hemianopia
- **3** – 3rd ventricle Glioma
- **P** – Pituitary macroadenoma
- **C** – Craniopharyngioma
- **A** – Anterior cerebral artery aneurysm
- **C** – Cavernous sinus aneurysm

3. Proximal Optic Nerve /Junction of Optic Nerve and Optic Chiasm/ Anterior Knee of Von Willebrand (Left)

Fibers	Visual field defect
Left (Ipsilateral) **optic nerve** Right (contralateral) **inferior Nasal fibers** (Inferior nasal fibers of optic nerve decussate in the chiasm and form a loop into the opposite optic nerve before crossing over into opposite optic tract)	Left (Ipsilateral) Anopia Right (contralateral) **superior temporal** quadrantanopia



Anterior knee of Von Willebrand



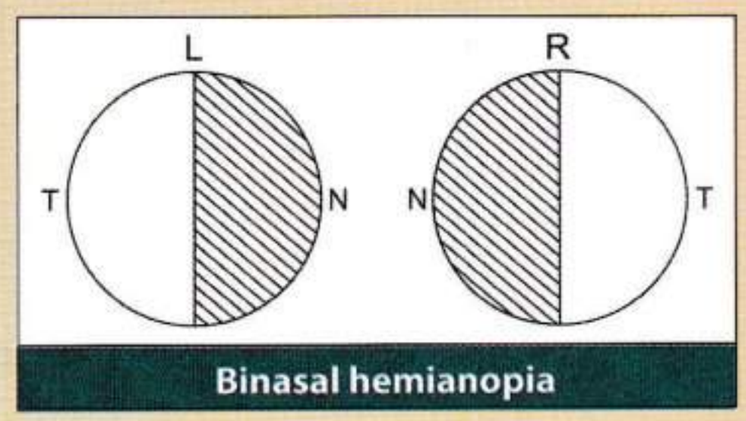
Traquair's Junctional scotoma

Cause

Most commonly due to meningioma

4. Lateral Optic Chiasm

Fibers	Visual field defect
Bitemporal (Temporal fibers ascend into optic tract without crossing)	**Binasal** visual field loss



Binasal hemianopia

Causes

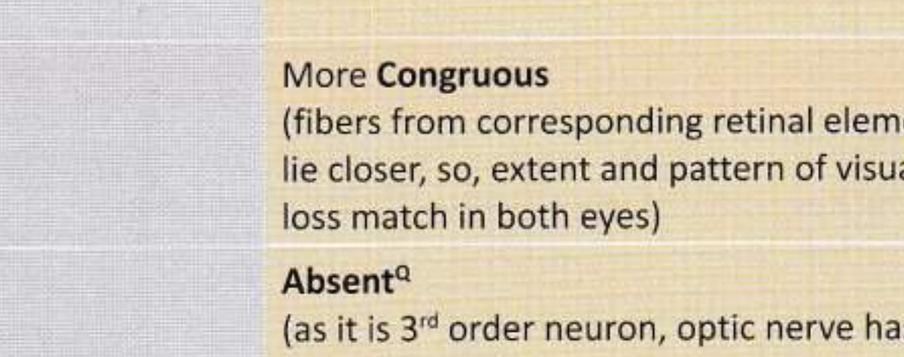
- 3rd ventricular distention—Hydrocephalus
- Posterior communicating artery atheroma
- Primary empty sella syndrome

Extra Mile

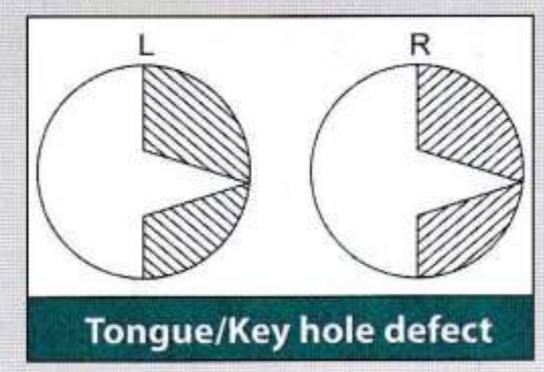
- Gadolinium enhanced MRI Scan - best imaging for perichiasmal lesions
- Hemifield slide Phenomenon - double vision (Diplopia) due to perichiasmal lesions

5. Optic Tract
6. Lateral Geniculate Body
7. Optic Radiations

(Left)

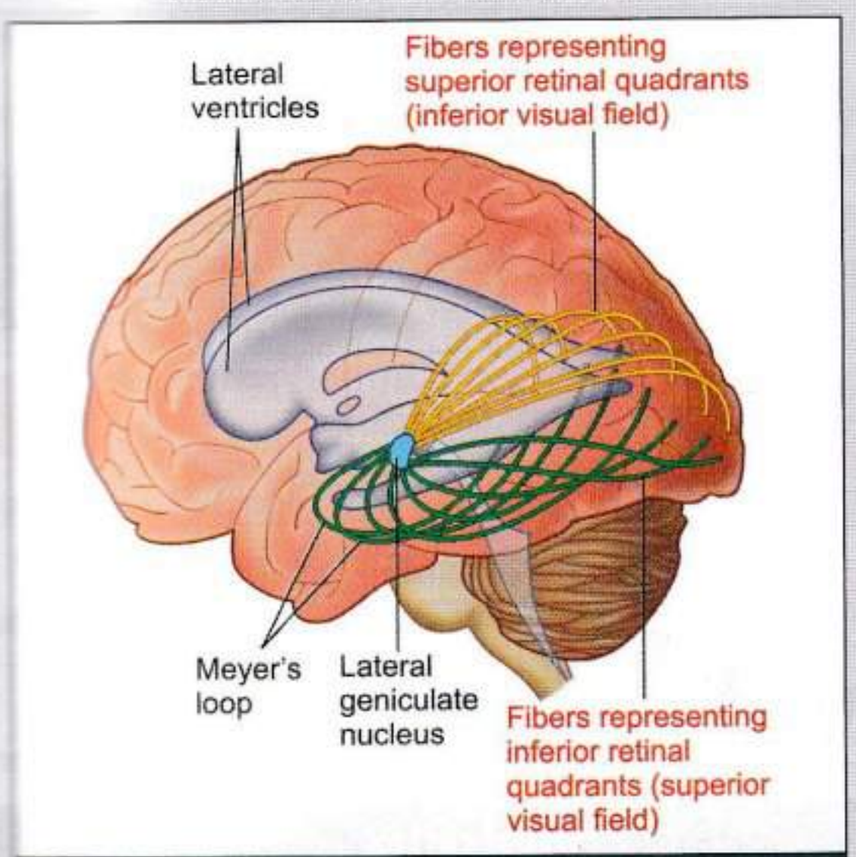
Fibers	Visual field defect
Left (Ipsilateral) **Temporal** → do not cross in optic chiasm Right (contralateral) **Nasal** → after decussating in optic chiasm	Left (ipsilateral) **Nasal** visual field loss Right (contralateral) **Temporal** visual field loss ↓ Both eyes visual field loss of Right side, i.e. Same (Homo)  **Right (contralateral) homonymous hemianopia** In pure hemianopsias - central visual acuity for letters is not affected- Known as **Complete macular splitting homonymous hemianopia**

Differentiation between Lesions of

	Optic Tract	Lateral Geniculate Body	Optic Radiations
Pupil	**Wernicke's Pupil** Behr's Pupil (Abnormal Light Reflex[Q])	Normal[Q]	Normal[Q]
Congruity	Incongruous	Incongruous	More **Congruous** (fibers from corresponding retinal elements lie closer, so, extent and pattern of visual field loss match in both eyes)
Optic Atrophy	Present • Ipsilateral-Superior and inferior loss of NRR • Contralateral-Bow tie pattern atrophy	Present	**Absent[Q]** (as it is 3rd order neuron, optic nerve has relayed in LGB)
Other Features	• May be associated with 3rd CN palsy • **C/L hemiplegia** (due to involvement of internal capsule) • **Causes** of optic tract lesion ▪ Syphilitic meningitis ▪ TB Meningitis ▪ Posterior cerebral artery aneurysm	• **Crossed nasal fibers** end in Laminae **1, 4, 6** • **Uncrossed nasal fibers end** in Laminae **2, 3,5** (Relay center for optic nerve) • Incomplete LGB lesions can present as Tongue or **Keyhole[Q] shaped defects/** Quadruple sectoranopia ↓ Due to lesion in Anterior choroidal artery distribution  **Tongue/Key hole defect**	**COGAN'S DICTUM[Q]** (helps to localize the lesion) ↓ On conducting optokinetic nystagmus (OKN) test ↓ Symmetrical OKN → Lesion in occipital lobe (Most common cause is Trauma) Erratic Pursuit movement → Lesion in Parietal lobe (Most common cause is Tumor)

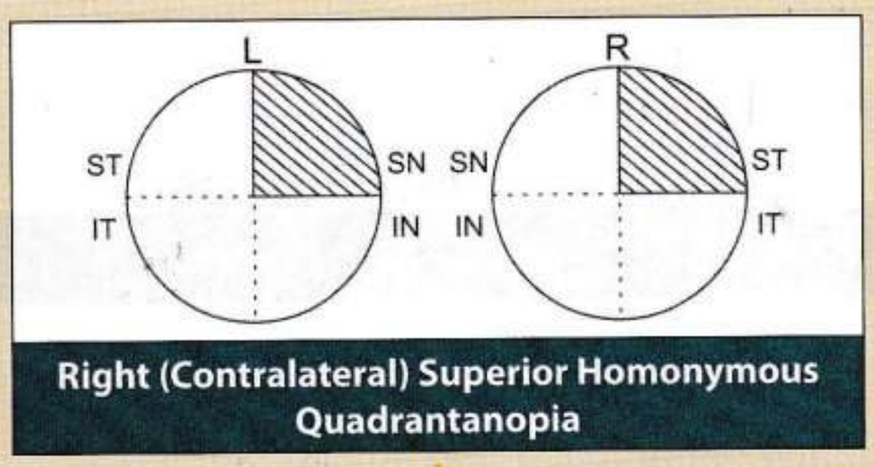
8. Temporal Lobe Optic Radiations/Meyers Loop[Q] (Left)

Fibers	Visual field defect
Inferior part of Optic Radiations ↓ Left (Ipsilateral) **Infero-temporal** Right (Contralateral) **Infero-nasal**	Left (Ipsilateral) **Supero-nasal** visual field loss Right (contralateral) **Supero-temporal** visual field loss


Lateral ventricles
Fibers representing superior retinal quadrants (inferior visual field)
Meyer's loop
Lateral geniculate nucleus
Fibers representing inferior retinal quadrants (superior visual field)

Meyer's loop

Inferior half of OR loop around lateral ventricle through the temporal lobe to the calcarine cortex



Right (Contralateral) Superior Homonymous Quadrantanopia

↓

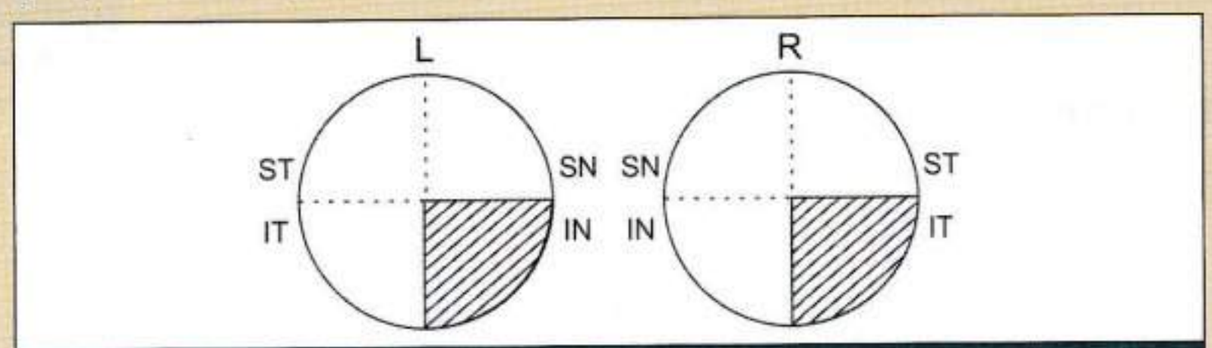
'PIE IN THE SKY'[Q]

(+)

Receptive dysphasia—if dominant temporal lobe involved and Unicinate fits, seizures, formed visual hallucinations

9. Parietal Lobe Optic Radiations[Q]/Baum's Loop (Left)

Fibers	Visual field defect
Superior part of Optic Radiations ↓ Left (Ipsilateral) **supero-temporal** Right (Contralateral) **supero-nasal**	Left (Ipsilateral) **Infero-nasal** visual field loss Right (contralateral) **Infero-temporal** visual field loss



Right (Contralateral) Inferior Homonymous Quadrantanopia

↓

'PIE ON THE FLOOR[Q]

(+)

Dominant lobe involved—Acalculia, Agraphia, Agnosia
Nondominant lobe involved —Apraxia

Mnemonic

T	I	P	S
Temporal lobe disease	Inferior Optic radiations ↓ Superior visual field loss - Pie in the sky	Parietal lobe disease	Superior Optic radiations ↓ Inferior visual field loss - Pie on the floor

10. Visual Cortex (Left)

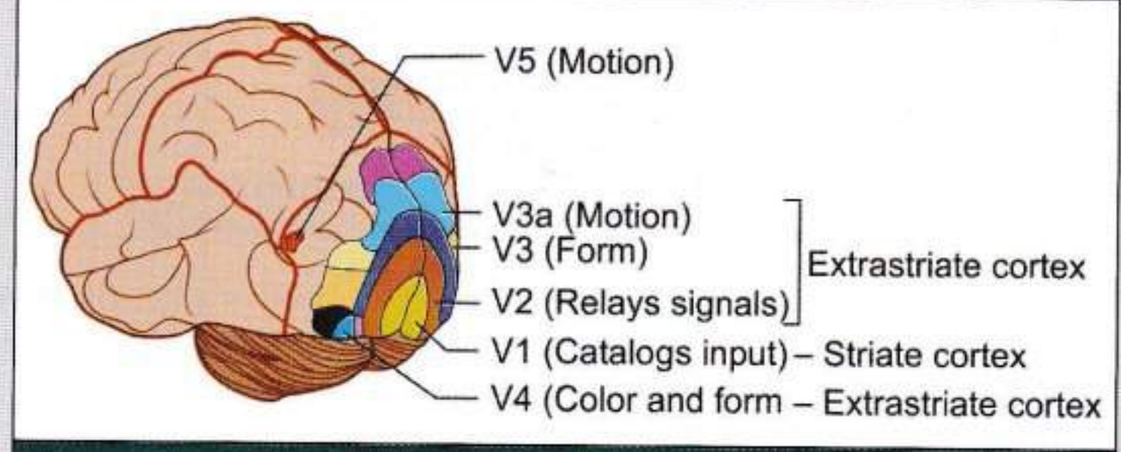
Correlate Box

V1 – Primary visual cortex-striate cortex (Brodmann's Area 17)
V2 – Area 18-Peristriate cortex
V3 – Area 19-Parastriate cortex, detects form and motion
V4 – For form and **color** –shows **attention** modulation
V5 – Motion

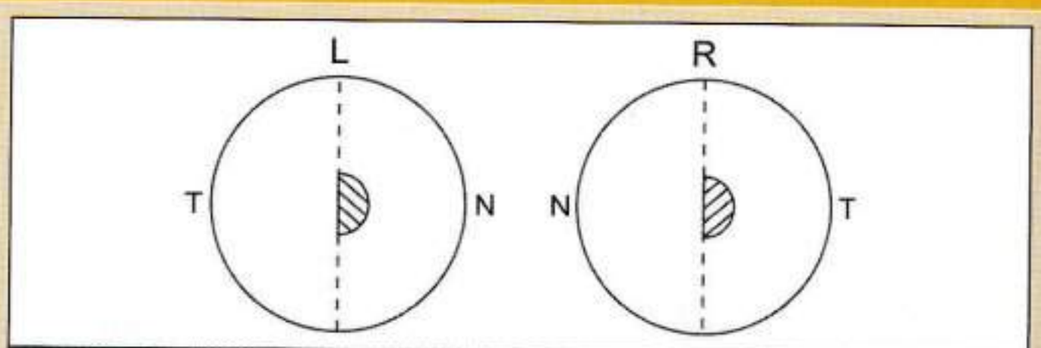
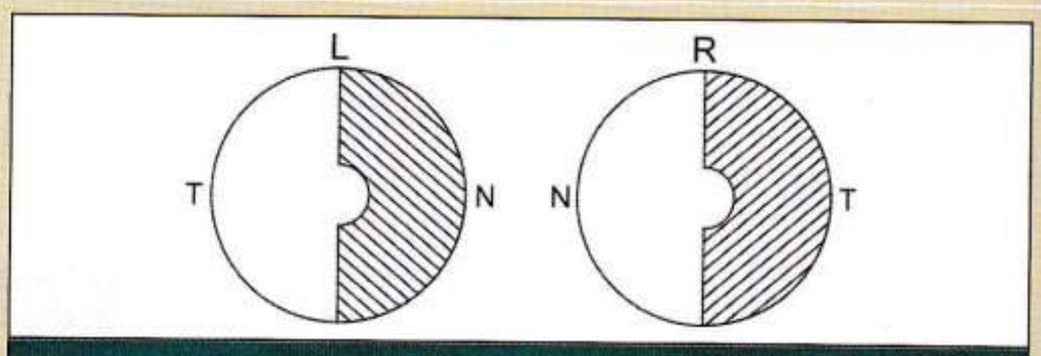
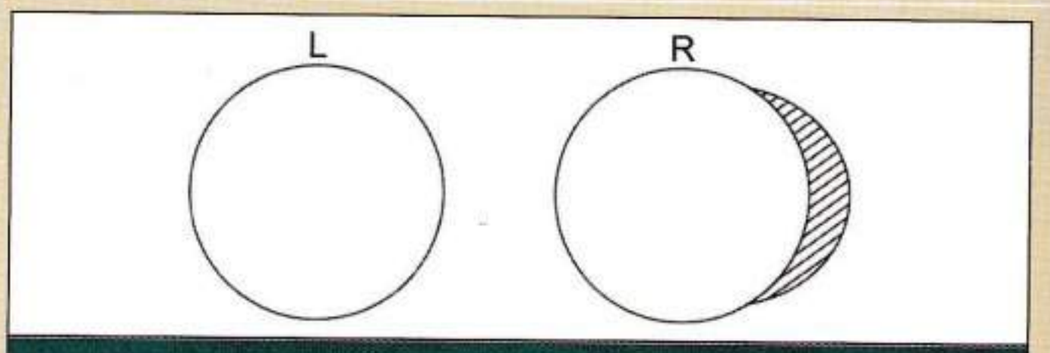
Blood Supply

Most of the occipital cortex is supplied by posterior cerebral artery (PCA).

In up to 75% cases, Middle cerebral artery (MCA) supplies the posterior TIP of visual cortex, which has representation from the central visual field, i.e. Macula



Visual cortex

	Visual field defect
A. Posterior TIP of visual cortex (Left) Often supplied by MCA or involved in Trauma	 Right (Contralateral) Homonymous macular defects
B. Intermediate visual cortex (Left) Due to occlusion of PCA	 Right (Contralateral) Homonymous Hemianopia with macular sparing
C. Anterior most visual cortex (Left) Adjacent to Parieto-Occipital fissure	 Mono-ocular temporal crescent defect of Right (contralateral) visual field

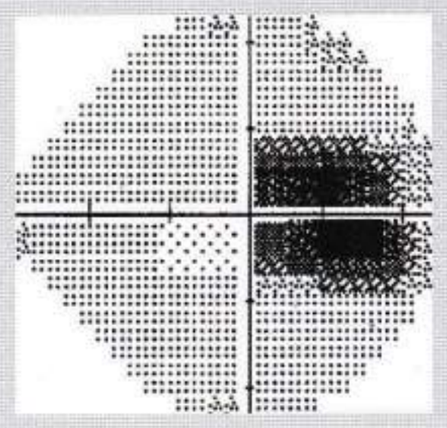
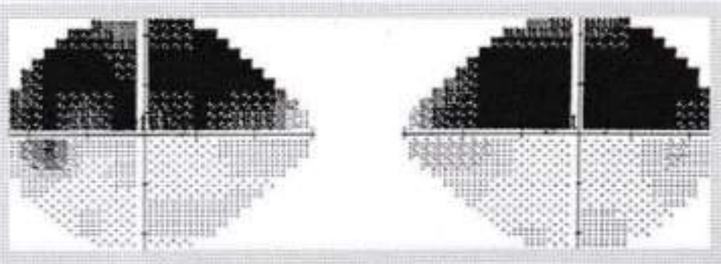
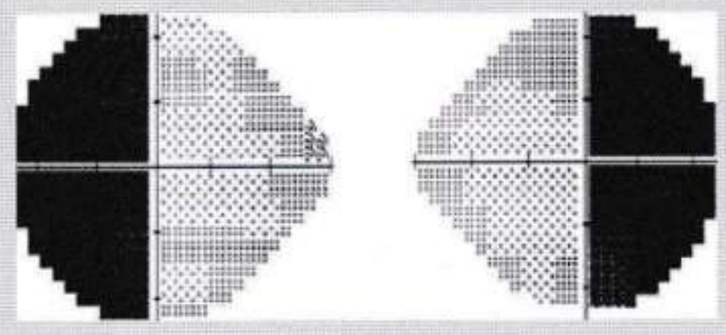
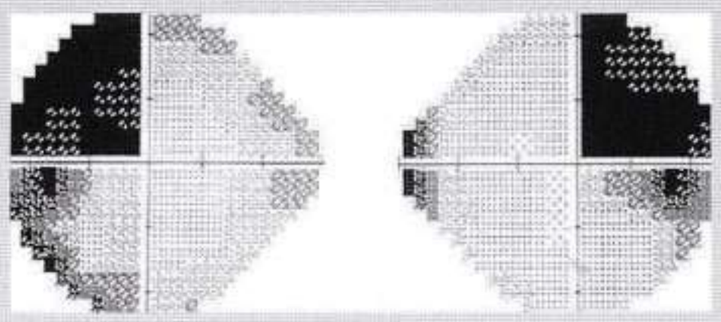
11. Cortical Blindness

- Bilateral occipital (visual cortex) lesion
- Features
  - No visual perception—Bilaterally Blind
  - Anton syndrome[Q]—Denial of blindness
  - Riddoch phenomenon[Q]—Perception of a dim kinetic, but not static bright visual targets
  - Pupillary responses are preserved
- Visual evoked potential (**VEP**)[Q] is the confirmatory diagnostic procedure.

VEP is used to differentiate between **organic causes of blindness (VEP is absent)** and **Functional visual loss** i.e. Malingering[Q] & Hysteria (VEP is Normal, No ocular signs, only sudden loss of vision complaint)[Q]

To Summarize, Visual Field Defects

HIGH YIELD

Optic nerve lesions		
Complete lesion	Ipsilateral anopia	
Hereditary optic neuropathy Toxic optic neuropathy[Q] Optic neuritis (Multiple sclerosis)	Central scotoma / Centrocecal scotoma	
Papilledema[Q] Optic disc drusen Optic neuritis Congenital optic disc lesions	Enlargement of blind spot	
Glaucoma[Q] Optic disc drusen[Q] Anterior ischemic optic neuropathy- (AION)[Q] BRAO	Altitudinal[Q] defects (Visual Field Defects which respect the horizontal midline)	
Optic chiasm lesions		
Central	Bitemporal Hemianopia	
Pituitary Adenoma—earliest lesion	Bitemporal superior quadrantanopia	

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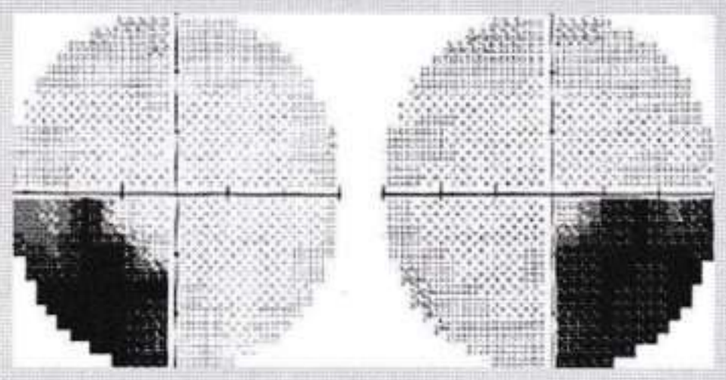
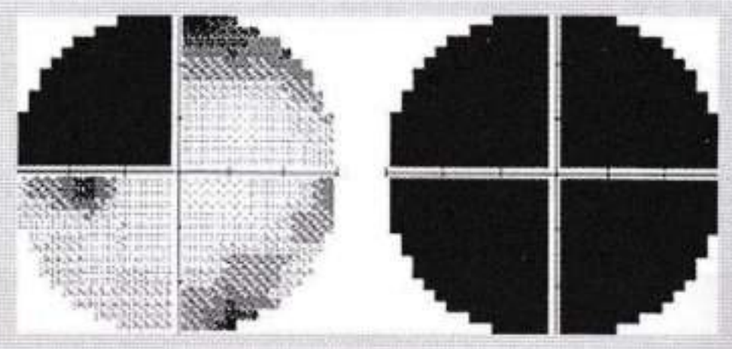
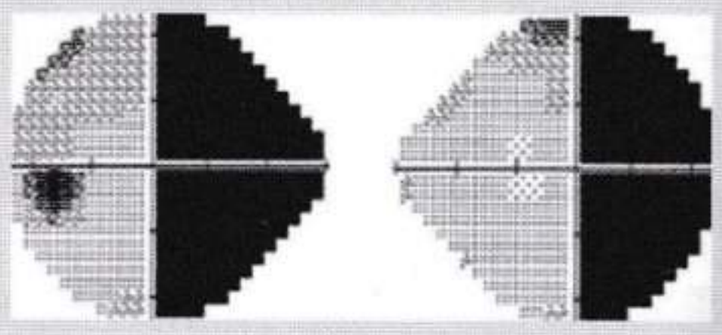
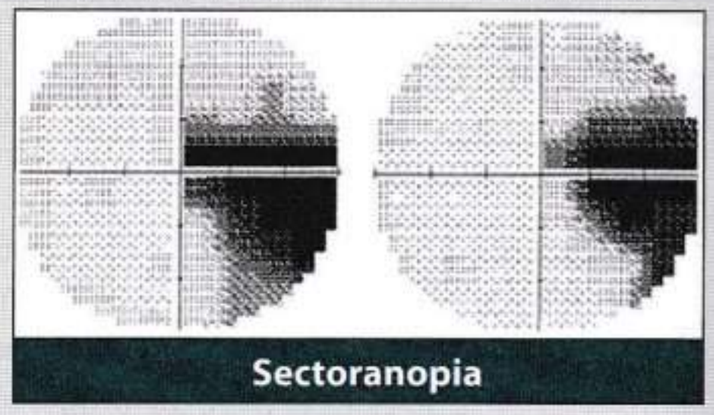
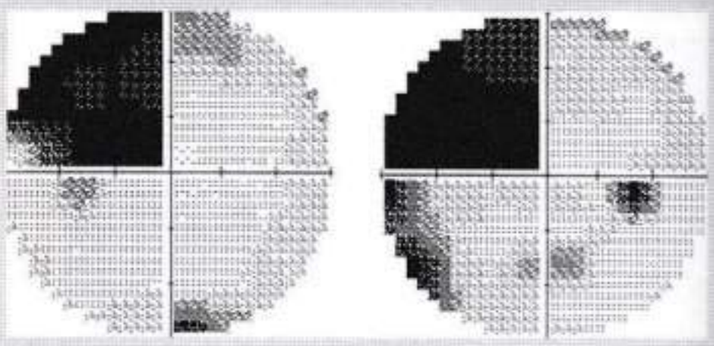
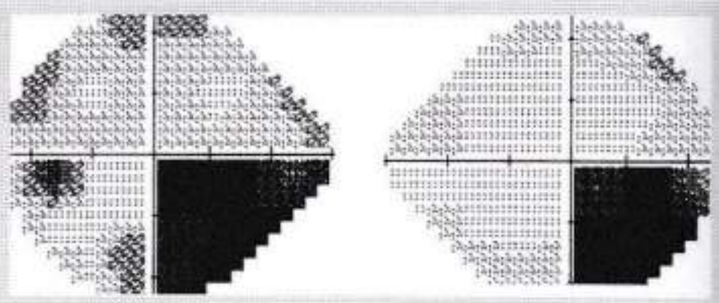
◦ Craniopharyngioma—earliest lesion	Bitemporal inferior quadrantanopia	
▪ Lateral (Bilateral)	Binasal Hemianopia	
• Anterior knee of Von Willebrand/ **Proximal optic nerve**	Junctional scotoma	
ALL defects posterior to optic chiasm are Contralateral and Homonymous		
• **Retrochiasmal lesions** (no further localizing value) ▪ Optic tract ▪ Lateral geniculate body ▪ Optic radiation	Contralateral complete Homonymous Hemianopia	
• Incomplete optic tract lesion	Contralateral incongruous incomplete homonymous Hemianopia	
• Incomplete LGB lesion	Contralateral homonymous • Tongue shaped defect • Key hole shaped defect • Sectoranopia	 **Sectoranopia**
• **Optic Radiation lesion**		
▪ Temporal lobe optic radiations	Pie in the sky	
▪ Parietal lobe optic radiations	Pie on the floor	

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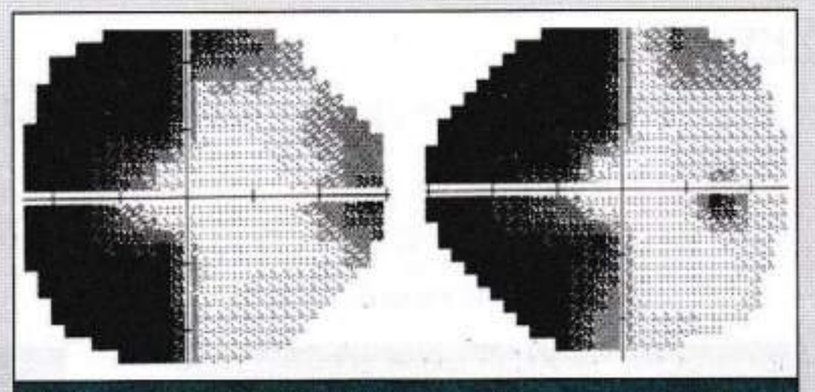
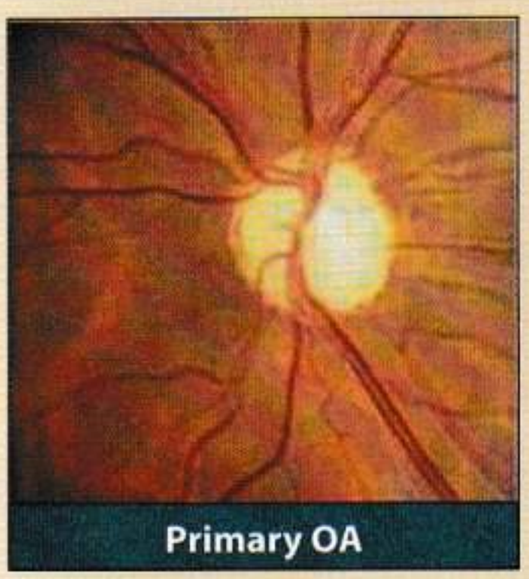
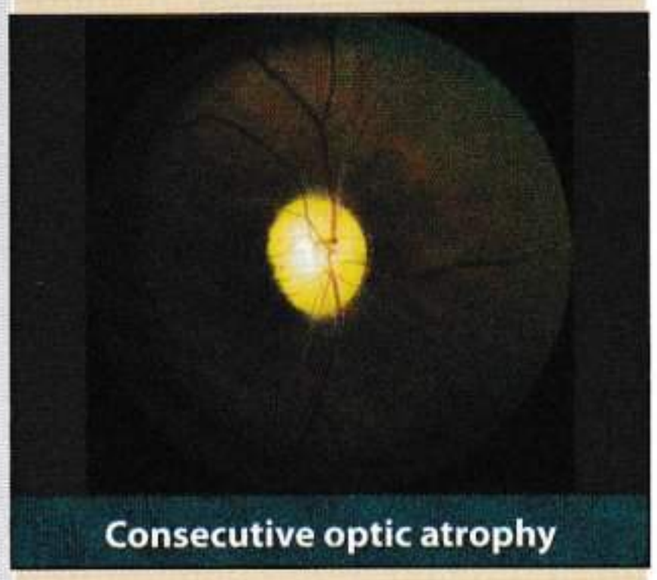
Occipital cortex lesion	
Tip of cortex – Middle cerebral artery	"Cookie Cutter" lesion-Macular defect
Cortex except TIP – Posterior cerebral artery	Macular sparing
Parieto-occipital lobe (anterior lesion)	Temporal crescent defect
Cortical blindness (Bilateral occipital lobe lesion)	Statokinetic dissociation



Macular sparing

OPTIC ATROPHY

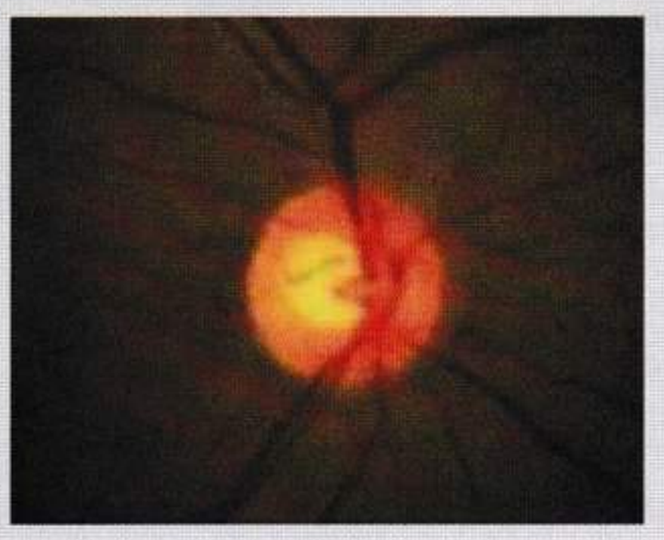
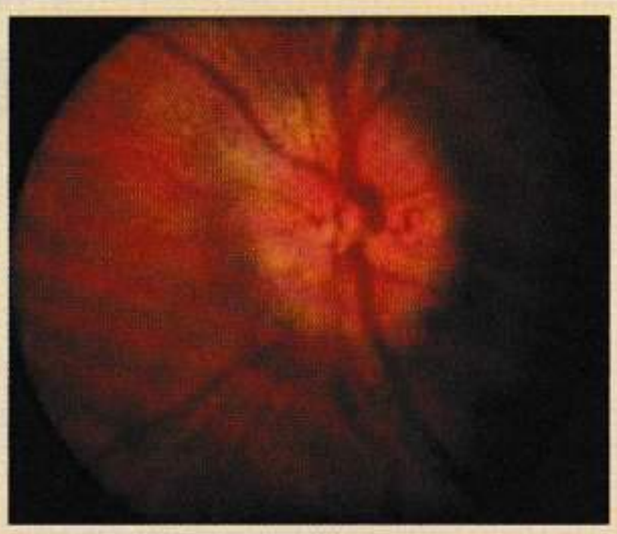
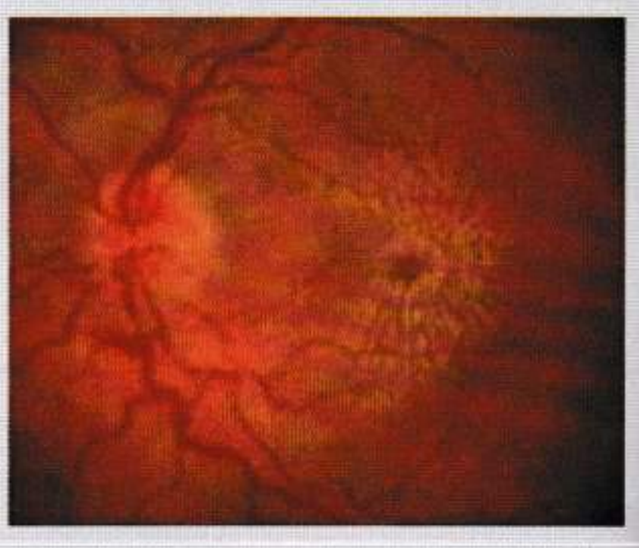
	Primary (1°)	Secondary (2°)	Consecutive
	Optic atrophy without antecedent optic disc swelling	Optic atrophy **after optic disc swelling**	Optic atrophy **due to disease of inner retina** and its blood supply
Disc appearance	**Chalky white**[Q], well-defined margins	Dirty gray-white[Q], **ill- defined margins**	Waxy pallor of disc, less sharply defined margins
Optic cup	Shallow, saucer shape	Filled up	Normal
Vessels	Normal	Peripapillary sheathing	Attenuation
Surrounding retina	Normal	Hyaline bodies/Drusen	Pathology seen
Causes	Optic neuritis[Q] Tumors Trauma Hereditary[Q] Toxic[Q]	Papilledema[Q] Papillitis[Q] Anterior Ischemic optic neuropathy (AION)	CRAO[Q]/CRVO Healed vasculitis Panretinal Photocoagulation Retinitis Pigmentosa
	 Primary OA	Secondary OA	 Consecutive optic atrophy

- Pallor of optic disc is the defining features of OA, and is not due to atrophy of nerve fibers, rather due to obliteration of vessels causing loss of vascularity
- Optic atrophy **does not correlate with visual loss**
- Kestenbaum **Index:** Ratio of small to large blood vessels on the disc surface. Normal is equal to 10. It is reduced in OA, < 7.

Optic Neuritis

Types

Depending upon the part of optic nerve inflamed

Ophthalmoscopic classification		
Retrobulbar neuritis	**Papillitis**	**Neuroretinitis**
		
• Optic nerve affected **behind the eyeball**	• **Optic nerve head** affected	• Concomitant swelling of optic nerve head (**papillitis**) and **macula** (inflammation of retinal nerve fibre layer)
• The **optic disc** appears normal • The condition may be truly described as 'the patient sees nothing and the doctor sees nothing.'	• **Hyperemia and edema** of the optic disc • May be a/w **peripapillary flame-shaped hemorrhages** • Retinal veins are tortuous • Exudates may accumulate upon disc	• **Macular star**[Q] (exudates that form around the macula give the appearance of the star)
• Most frequent type in **adults** • Frequently associated with **multiple sclerosis** (MS)	• Most common type in **children** and young adults	• Least common type • Not associated with multiple sclerosis • Due to viral infection

Causes

Demyelinating	Infectious and para-infectious causes	Others
• Multiple sclerosis • Neuromyelitis optica (Devic disease – bilateral optic neuritis with transverse myelitis) • Schilder's disease • Encephalitis periaxialis concentrica	• Viral (adenovirus, coxsackievirus, measles, mumps, rubella, varicella-zoster) • Bacterial (syphilis, tuberculosis, lyme disease, cat-scratch disease, β-hemolytic streptococcal infection, brucellosis, typhoid fever, meningococcal infection, Whipple's disease)	• Post-vaccination • Inflammation (sarcoidosis; vasculitidis, e.g., SLE; polyarteritis nodosa) • Miscellaneous (Guillain-Barre syndrome, birdshot retinochoroidopathy, intraocular nematode infection, toxoplasmosis, toxocariasis)

Clinical Features

(Unless otherwise specified, optic neuritis in a MCQ means either idiopathic or associated with multiple sclerosis)

- Affects-18–45 years
- Sudden[Q], Painless loss of vision[Q] – **Unilateral**[Q] – starts to improve by 2nd or 3rd week
- Pain may precede loss of vision—Deep, orbital retrobulbar pain aggravated by eye movement[Q]
- Tenderness of eyeball with frontal headache and neuralgia
- Marcus Gunn pupil/**RAPD**[Q] **—earliest sign**
- Red-Green color deficiency with altered contrast sensitivity (Take longer to recover than visual activity)
- **Pulfrich phenomenon**—altered perception of kinetic objects
- **Uhthoff sign**—worsening of symptoms with exercise or increased body temperature
- Visual Field Defect[Q] – **Central Scotoma**[Q] > Altitudinal defects > Centrocecal Scotoma

- Optic disc-Retrobulbar Neuritis > Papillitis, leading to optic atrophy
- VEP shows prolonged latency (delayed transmission time) and reduced amplitude.

Treatment

- Optic nerve treatment trial **(ONTT) guidelines**: Treat with IV Methylprednisolone 1 g daily for 3 days – Oral prednisolone 1 mg/kg/day for 11 days only if -
  - Profound visual loss (<6/12 within first week)
  - No previous history of optic neuritis or multiple sclerosis
  - MRI shows at least 1 area of demyelination.

This treatment fastens recovery of visual activity, reduces frequency of relapse but does not affect final visual outcome.[Q]

Patients treated alone with **oral** prednisone demonstrated an increased risk of recurrent optic neuritis.[Q])

- Controlled High Risk Avonex Multiple Sclerosis Trial **(Champs) Study** - advocated use of **β-interferon** Ia in high-risk patients after steroid regime to reduce subsequent risk of multiple sclerosis in patients of optic neuritis.
- Glatiramer **acetate**-20 mg subcutaneously daily

Correlate Box

Characteristic demyelinating lesions in patients at risk of multiple sclerosis are

- 3mm or larger in diameter
- Ovoid
- Located in periventricular areas of white matter
- Radiate towards the ventricular spaces

Oligoclonal banding of proteins in CSF is a useful predictor of MS in patients who do not have characteristic findings on MRI

Mnemonic

Features of Optic Neuritis – 2 (CUP Mar)

C – Central scotoma
C – Color vision (Red-Green defect)
U – Unilateral visual loss
U – Uhthoff sign
P – Pulfrich phenomenon
P – Pain aggravated on head movement
M – Marcus gunn pupil/RAPD
M – Multiple sclerosis (Most common cause)

Hereditary Optic Neuropathy

	Inheritance	Age at Presentation	Systemic Associations
Dominant Optic Atrophy (DOA)	AD	5–10 Years, bilateral insidious visual loss	Sensorineural hearing loss
Leber	AR	1st decade	**Mnemonic** **ANM** **A**taxia, **N**ystagmus, **M**R
Wolfram/DIDMOAD	AR	5–21 years	3D • DI-Diabetes insipidus • DM-Diabetes mellitus • D-Deafness
Leber (LHON)	Mitochondrial	15–30 years[Q]	

Leber Hereditary Optic Neuropathy

Mitochondrial DNA[Q] inheritance—**P**oint mutation[Q] at 11778

↓

Maternally transmitted (Males do not Transmit)[Q]

↓

Most commonly manifested in males (SON) in 2nd to 3rd decade

Clinical Features [Remember as 6P]

- Unilateral, **sudden painless** loss of vision → fellow eye[Q] involved after weeks to years → **Bilateral symmetrical, Visual Loss**[Q] – usually presents in **young** adults
- Hyperemic disc with obscuration of disc margins and absence of leakage[Q] of dye on FFA
- **Peripapillary Telangiectatic** microangiopathy[Q]
- **Pseudo-edema**/Pseudopapillitis
- Primary optic atrophy[Q]
- Central or Centrocecal scotoma[Q]
- Normal pupillary reactions[Q]
- On OCT
  - In affected carriers: Thickening of temporal retinal fibers seen
  - In patients thickening of superior and inferior fibers seen in acute phase
  - When OA supervenes-**Pathognomonic sign-nerve fiber layer** dropout of small fibers of **papillomacular bundle**
- There is NO treatment, genetic counseling offered

Mnemonic

Causes of pseudo-papilledema
LHON
Methanol poisoning
Near visual loss in hypermetropia
Optic disc Drusen
Peripapillary myelinated nerve fibers

Toxic Nutritional Optic Neuropathy/Toxic Amblyopia

Cause

Chronic retrobulbar neuritis due to

- Vitamin deficiencies (B_1, B_2, B_{12}, folate)
- Toxic agents—Methyl alcohol[Q], Tobacco-Cyanide[Q]
- Drugs—**D**igoxin[Q], **I**soniazid[Q], **C**hloroquine[Q], **E**thambutol[Q]

] Interfere with mitochondrial oxidative phosphorylation

Clinical Features

- Bilateral[Q], Insiduous progressive visual loss with Dyschromatopsia
- Bilateral centrocecal Scotoma[Q]
- Optic disc—Usually normal[Q], until primary optic atrophy[Q] occurs

Treatment

1000 Units of hydroxocobalamin weekly for 10 weeks

Papilledema

Passive hydrostatic, **bilateral**[Q], **noninflammatory**[Q], **painless**[Q] swelling of optic nerve head/optic disc, secondary **to raised**[Q], **intracranial pressure (ICP)**

ONH swelling in absence of raised ICP is known as pseudo-papilledema or optic disc edema

Pathogenesis

Elevated ICP (CSF pressure) is transmitted along subarachnoid space to optic nerve as the nerve is enclosed upto Lamina cribrosa within the meningeal sheaths common to brain

↓

Blockage of axoplasmic transport[Q]

↓

Stasis in optic nerve head

↓

Swelling of nerve fibers (**Extracellular edema**)[Q] | Secondary vascular changes (**Venous congestion**)

Causes[Q]

Any cause of raised ICP can lead to papilledema, as subarachnoid space of brain is continuous with the optic nerve sheath.

Mnemonic

MOVIES

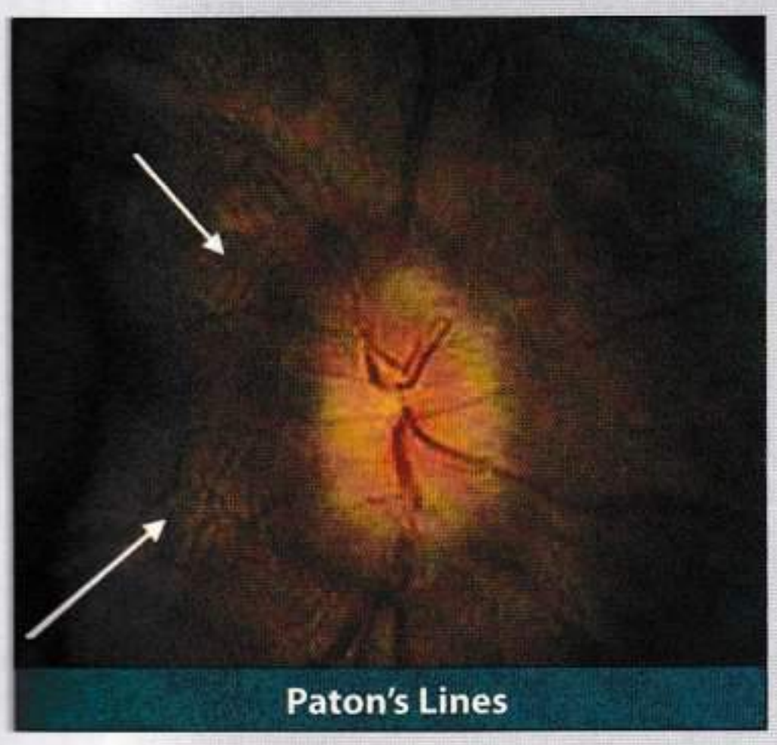
M alignant hypertension or essential hypertension (Grade IV retinopathy)
O bstructive hydrocephalus
V enous sinus thrombosis (Cavernous)
I diopathic intracranial hypertension-Pseudotumor cerebri
E ndocrinal-Toxemia of pregnancy
S pace occupying intracranial lesions (Tumours)

Clinical Features

Symptoms

- **Headache** – Worse in morning and with coughing, bending, etc. (Earliest symptom)
- Nausea and **projectile vomiting** – which relieves headache
- Transient visual obscurations – **Amaurosis Fugax**[Q]
- Horizontal diplopia – Due to 6th CN palsy (false localizing sign)
- **Normal vision – Optic disc is blind spot**, so no loss of vision, blindness sets in when optic atrophy occurs
- **Normal pupillary reactions**

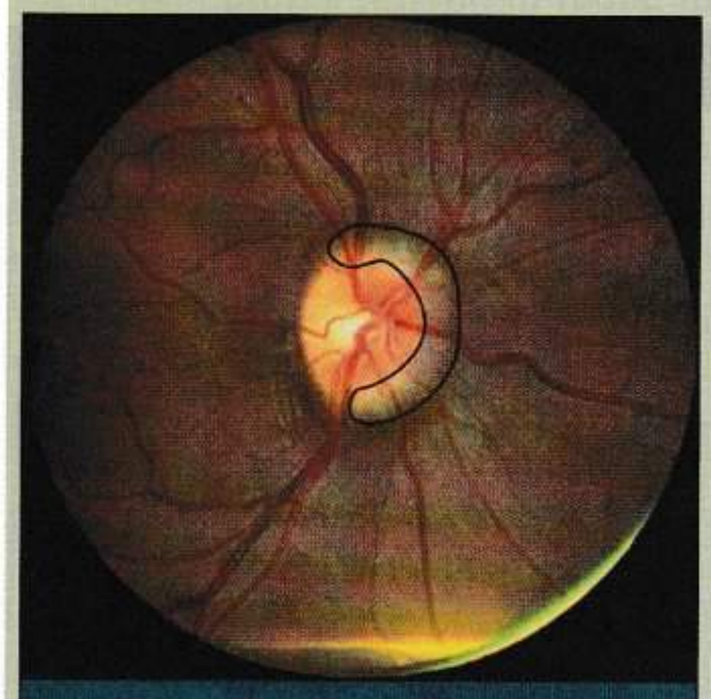
Signs

Mechanical	Vascular
• **Earliest sign**[Q]-Blurring of disc margin[Q] (Nasal) • Filling in of optic cup[Q] • Anterior extension/elevation of optic nerve head[Q] • Edema of nerve fiber layer • Retinal or choroidal folds - **Paton's Lines**[Q]  **Paton's Lines** • Chronic papilledema presents with Champagne cork appearance of optic disc • In the atrophic stage, swelling subsides and secondary OA occurs	• **Hyperemia** of optic disc[Q] • Venous engorgement[Q] and congestion[Q] • Peripapillary splinter hemorrhage • NFL infarcts - cotton wool spots • Exudates radiate from the center in form of a **Macular Star or Macular Fan** appearance • Absence of normal venous pulsations (absent in 20% normal population also) • Optociliary shunts on disc surface in chronic cases

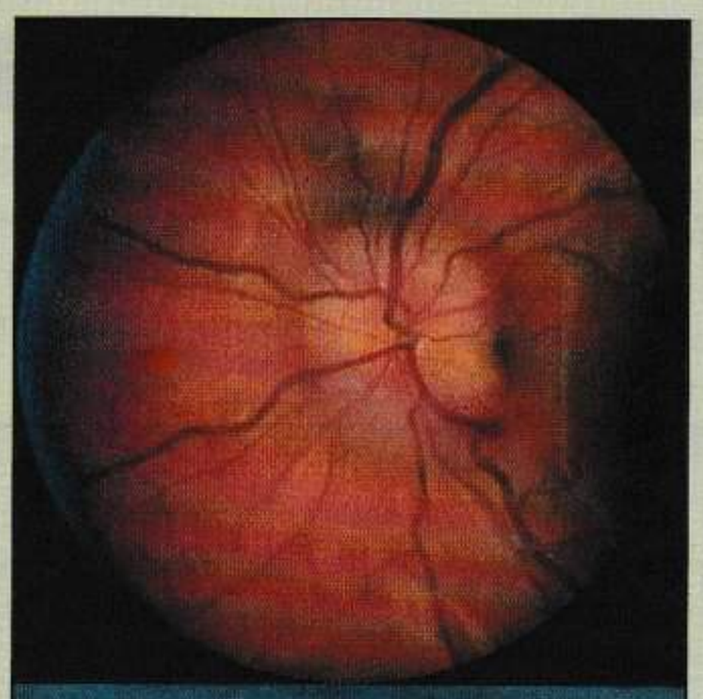
Visual Field Defects

- Enlargement of Blind spot[Q]
- Peripheral field constriction

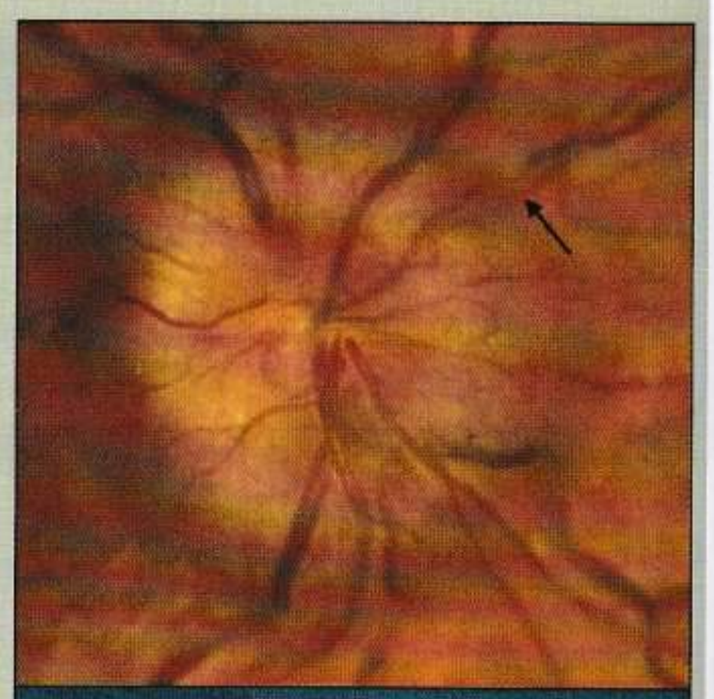
- **FRISEN'S Scale** – for grading of papilledema



Grade I
Characterized by a C-shaped halo with a temporal gap

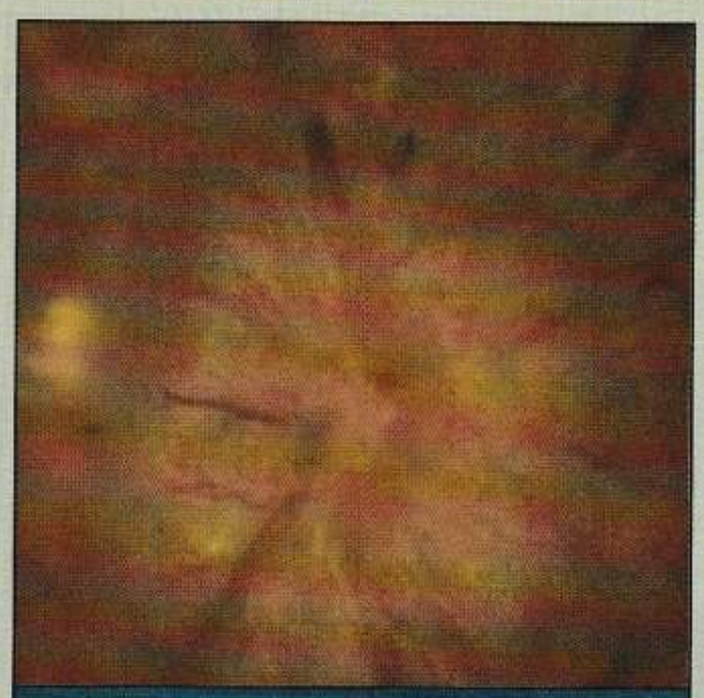


Grade II
The halo becomes circumferential



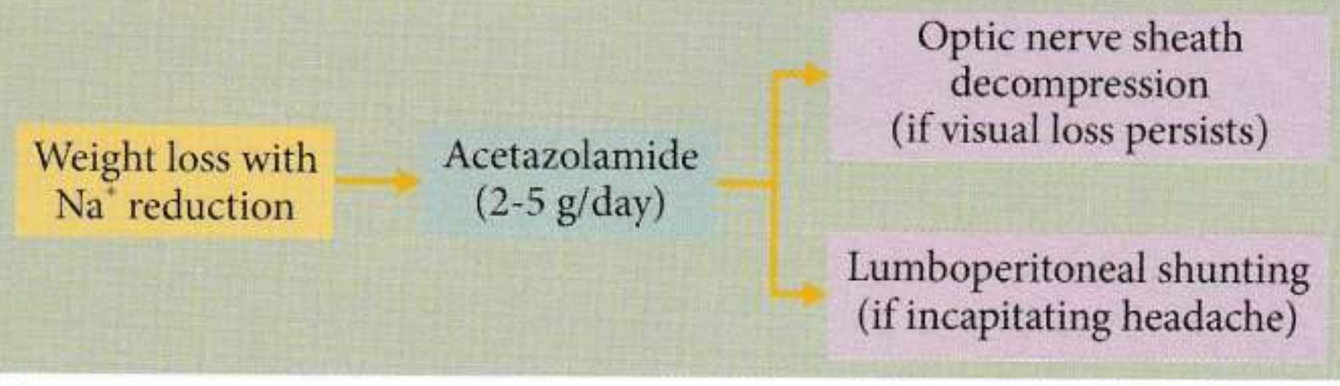
Grade III
Characterized by loss of major vessels as they leave the disc (arrow)

Grade IV
Loss of a major blood vessel on disc



Grade V
Obscuration of all vessels on and leaving the disc

- **Foster kennedy syndrome:** Unilateral papilledema with OA in other eye—most commonly due to frontal lobe/olfactory groove/pituitary tumor
- **Pseudo-Foster Kennedy syndrome:** Unilateral disc edema with OA in other eye due to AION, Arachnoiditis, Trauma or Syphilis
- **Pseudotumor Cerebri (Benign/Idiopathic Intracranial Hypertension)**
  - Raised ICP without any primary cause (No mass lesion or obstruction of ventricular system)
  - Mostly seen in **obese Females**^{Q}, **20-30 years** of age
  - Symptoms: Headache (Most common), Amaurosis Fugax (bad prognostic factor), Pulse synchronous Tinnitus with visual loss
  - **Opening CSF pressure is > 250 mm H_2O (raised)**
  - Treatment:


Weight loss with Na+ reduction
Acetazolamide (2-5 g/day)
Optic nerve sheath decompression (if visual loss persists)
Lumboperitoneal shunting (if incapitating headache)

Anterior Ischemic Optic Neuropathy (AION)

AION occurs due to interference of blood supply to the anterior part of optic nerve (posterior ciliary artery)

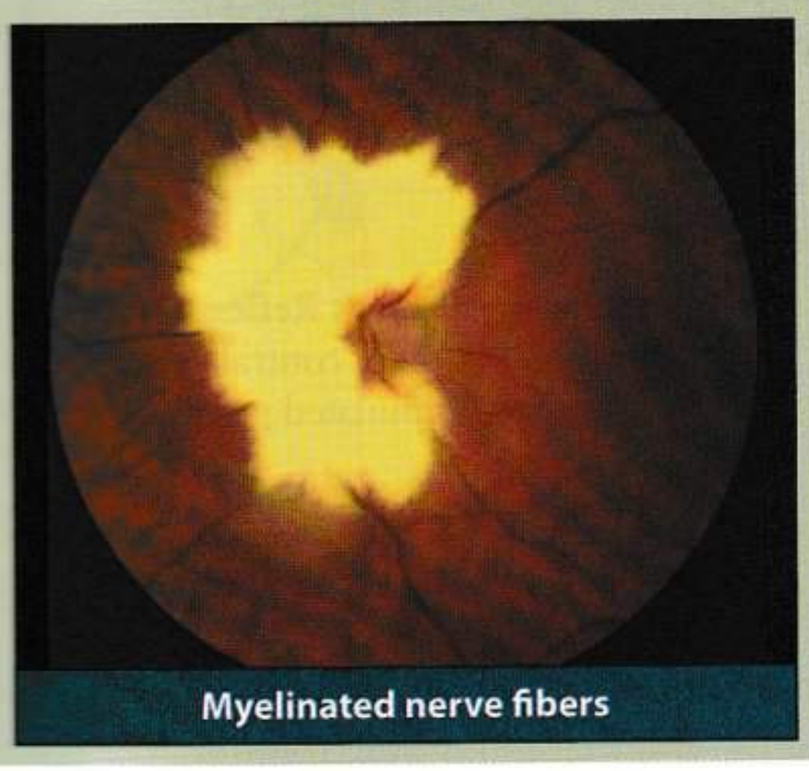
AION can be clinically differentiated into

Arteritic AION	Nonarteritic AION
• Due to **Giant cell Arteritis**[Q]	• Due to **occlusion** of short posterior ciliary artery
• Sudden, Severe[Q] visual loss (<6/60)	• Sudden, Moderate visual loss (> 6/60, non-progressive)
• Most common in females, 7th–8th decade	• Most common in males, 5th–6th decade
• Premonitory **symptoms** like Pain[Q], Amaurosis Fugax present	• Absent
• Usually Bilateral[Q] – fellow eye affected within days to weeks	• Usually Unilateral (> 70%)
• Pale optic Disc	• **Hyperemic** optic disc with small cup
• Associated with headache, palpable & tender, nonpulsatile temporal artery[Q], CN palsies, Jaw claudication	• Associated with hypertension, diabetes, hyperlipidemia, collagen vascular disease, hypotensive shock etc.
• On FFA Disc and Choroidal filling delay	• On FFA Disc filling delay only
• **Treatment** Corticosteroids[Q] – 1-2 g/day I.V. methylpred Aspirin (150 mg/day) Immunosuppressants	• **Treatment** Levodopa-Carbidopa combination for 3 weeks
• **Poor prognosis**	• Good prognosis
• **Visual field defect** Inferior Altitudinal[Q] defect Central scotoma	• **Visual field defect** Inferior Nasal **Altitudinal**[Q] defect Central scotoma

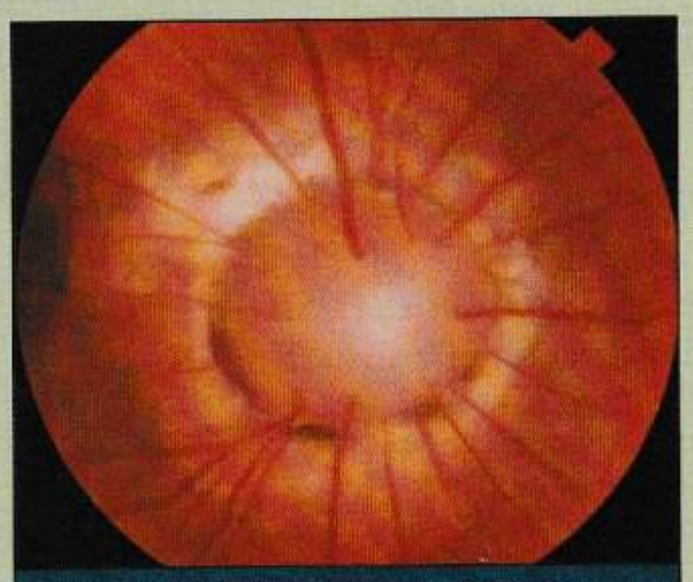
EXTRA MILE

Congenital Anomalies of Optic Disc

- **Myelinated Nerve Fibers** - Myelination normally stops posterior to eyeball (cribriform plate). If retinal ganglion cells retain a myelin sheath, visible as white streaks
- **Morning Glory Syndrome**[Q]
  - It is defined as malformation of the optic disc associated with
    - a peripapillary scleral defect
    - absence of lamina cribrosa[Q]
    - a recess formed by an axial retro displacement of the optic nerve
  - Unilateral, large disc with a central, funnel shaped excavation surrounded by a raised pink neuroglial tissue
  - Blood vessels emerge from rim in a radial pattern like spokes of a wheel
  - Believed to be a mesodermal defect
- **Bergmeister papilla** – Remnant of hyaloid artery
- **Optic disc hypoplasia** – presents with double ring sign



Myelinated nerve fibers



Morning glory syndrome

Blood vessels emerge from rim in a radial pattern like spokes of a wheel

PUPIL

Pupil is an **aperture** in iris which controls the amount of light entering the eye by

Miosis	Constriction of pupil (< 2 mm)	Sphincter pupillae (inner circular muscle)	Parasympathetic → oculomotor nerve → Short ciliary[Q] nerve
Mydriasis	Dilatation of pupil (> 7 mm)	Dilator pupillae (outer radial muscle)	Sympathetic → Long ciliary[Q] nerve

Mnemonic

Causes of MYDRIASIS – ITS COMB

Internal ophthalmoplegia
Tonic pupil (Holmes adie pupil)
Sympathomimetics
Closure angle glaucoma
Oculomotor 3rd nerve palsy
Mydriatics (**A**tropine/homatropine/tropicamide)
Belladonna Poisoning

Causes of MIOSIS – HI COPS

H- Horner syndrome
Hemorrhage (Pontine)
I- Iridocyclitis (anterior uveitis)
C- Clonidine
Carbolic acid
O- Organophosphates
Opioids (morphine)
P- Parasympathomimetic drugs
(Phenothiazine/pilocarpine)
S- Sleep
Sedatives (Barbiturates)

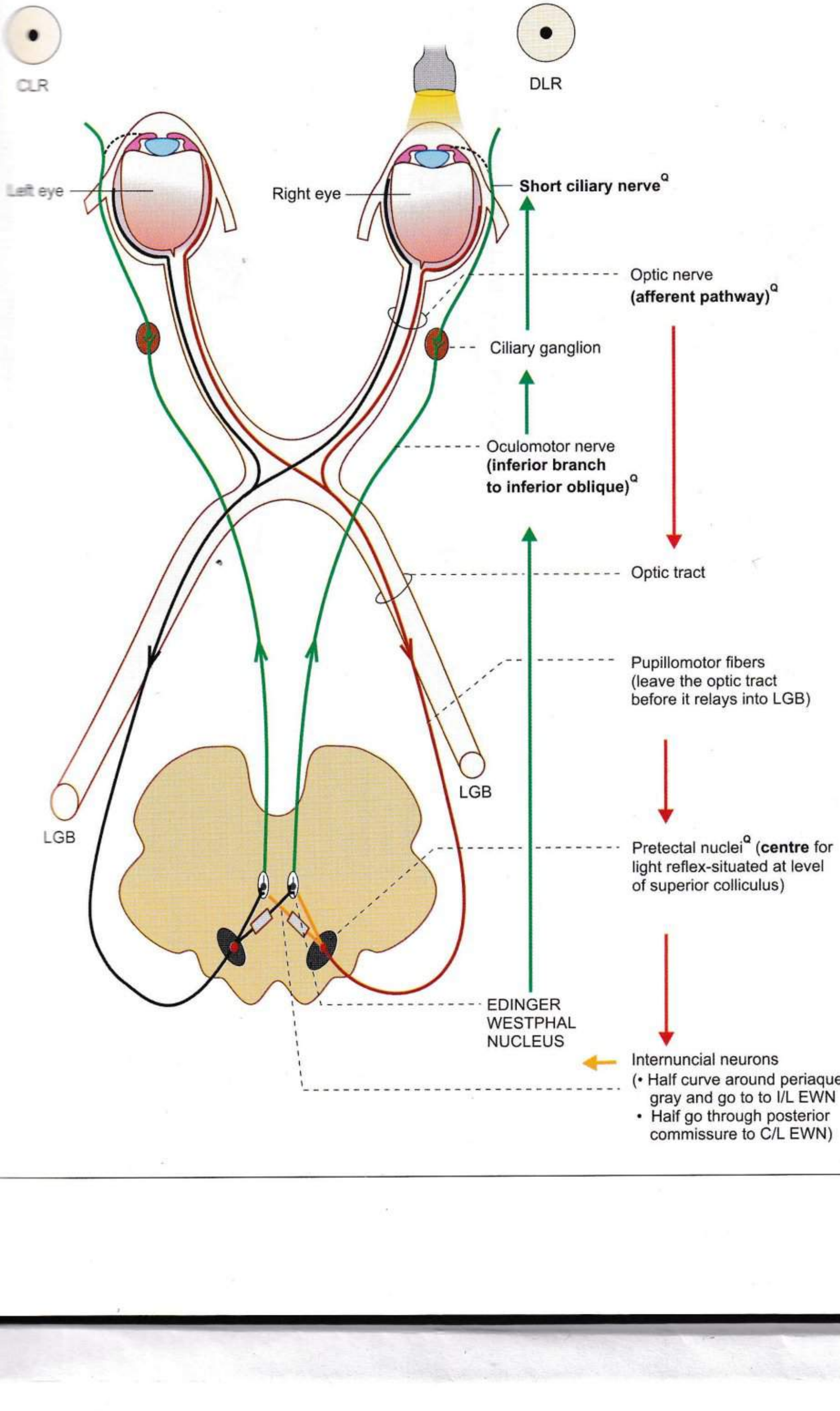
Pupillary Reflexes

- **Near Reflex:** Miosis + Convergence + Accommodation
- **Ciliospinal Reflex:** Dilatation of Ipsilateral pupil (Mydriasis) in response to pain on neck, face and upper trunk
- **Psychosensory Reflex:** Dilatation of pupil with stress, emotion
- **Light Reflex:** Constriction of pupil in response to light exposure

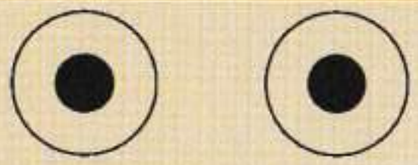
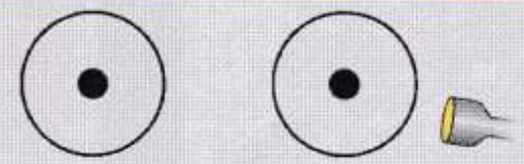
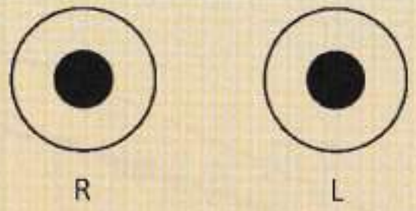
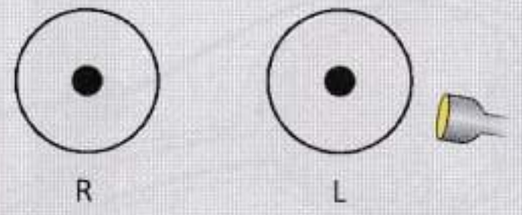
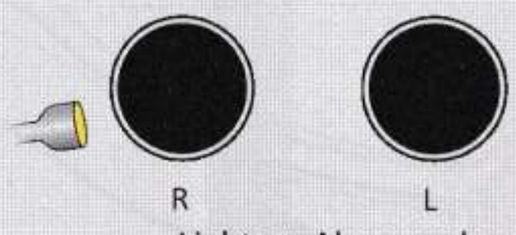
Direct Light Reflex (DLR)
Constriction of ipsilateral, stimulated pupil

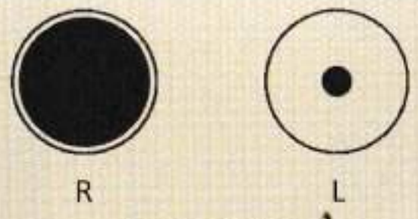
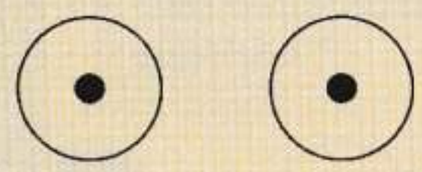
Consensual Light Reflex (CLR)
Constriction of contralateral, non-stimulated pupil

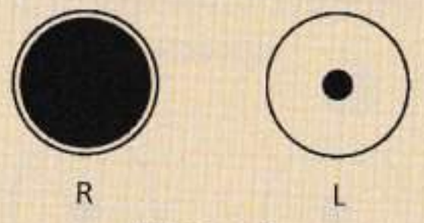
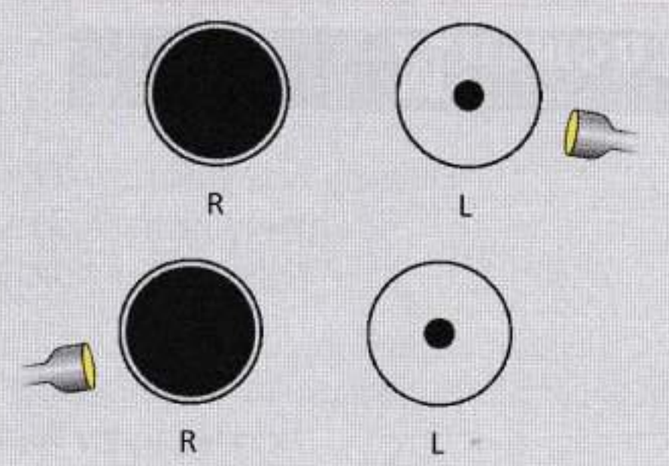
Pupillary Light Reflex



Pupillary Abnormalities

	Site of Lesion	Causes	Pupil at Presentation	Light Reflex	Special Points
Afferent Defects					
Absolute Afferent pupillary defect (AAPD) or Amaurotic Pupil[Q]	Optic Nerve	Complete Optic nerve lesion	 R L **Isocoria** (Equal pupil size in both eyes)	 R L Light on Normal eye (LE) ↓ Both pupil constrict R L Light on abnormal eye (RE) ↓ Both pupils Do Not constrict **(I/L DLR and C/L CLR Absent)**	• No Perception of light in involved eye • Near reflex present
Relative afferent pupillary defect (RAPD) or Marcus Gunn Pupil[Q]	Retina or optic nerve	Incomplete optic nerve lesion • Optic neuritis[Q] • CRAO/CRVO • Retinal detachment	 R L **Isocoria** (Equal pupil size in both eyes)	 R L Light on normal eye (LE) ↓ Both pupil constrict  R L Light on Abnormal eye (RE) ↓ Both pupil Dilate **PARADOXICAL DILATATION** Pupillary Escape Phenomenon (Dilatation produced by withdrawing light from normal eyes outweighs constriction by abnormal eye)	**Swinging Flashlight[Q] Test** is done for Diagnosis– ↓ Leads to fatigue of neural tissue– ↓ Earlier on the side of lesion

	Site of Lesion	Causes	Pupil at Presentation	Light Reflex	Special Points
Wernicke Hemianopic Pupil	Optic Tract[Q]	• Tubercular meningitis • Syphilitic meningitis	Isocoria with normal size pupils	As the patient suffers from Homonymous Hemianopia stimulating pupil in the blind half of visual filed does not elicit any response	
Efferent Defects					
TONIC Pupil or ADIE Pupil[Q]	Ciliary Ganglion or Short ciliary nerve	• HZV ganglionitis • Orbital trauma • Neuropathic • Diabetes/ Aneurysm • Holmes-adie pupil Tonic pupil (+) diminished deep tendon reflexes	 R L **Anisocoria** (Unequal pupil size in both eyes) ↓ Unilateral dilated pupil in the affected eye	 R L Light on normal eye (LE) ↓ (LE) Normal pupil constricts (RE) Abnormal pupil does not constrict ↓ I/L CLR absent[Q] R L Light on Abnormal eye (RE) ↓ (LE) Normal pupil constricts (RE) Abnormal pupil does not constrict ↓ I/L DLR absent[Q] **Thus, ABNORMAL pupil is ALWAYS DILATED except during NEAR REFLEX** (NEAR Reflex Present[Q], but shows slow, redilating **vermiform** movements)	**Denervation Hypersensitivity test** ↓ 0.125% (diluted) Pilocarpine → If pupil does not constrict ↓ Normal pupil (Constricts with 1%) → Pupil Constricts ↓ Tonic pupil
Argyll Robertson pupil (ARP)[Q] or Prostitute's pupil	Periaqueductal Tectal region or Posterior commissure	• Neurosyphilis[Q] • Tabes Dorsalis • Aortic Regurgitation	 R L **Isocoria** Bilateral constricted pupil Irregular shaped	• Bilateral Light Reflex (DLR and CLR) Absent[Q] • Bilateral Near Reflex Present[Q] **Mnemonic** **A**ccommodation **R**eflex **P**resent **P**upillary light **R**eflex **A**bsent	• Pupil doesnot constrict with miotics (Pilocarpine) • Does not dilate with mydriatics (Atropine[Q])

	Site of Lesion	Causes	Pupil at Presentation	Light Reflex	Special Points
Inverse ARP	Occipito-tectal tract	• Diphtheria • Encephalitis		Bilateral light reflex present Bilateral near reflex absent	
Pharmacological Mydriasis	Supranuclear inhibition of Edinger westphall nucleus	Use of Topical atropine/ homatropine (Mydriatics)	 **Anisocoria** DILATED[Q] pupil in affected eye	 Presents similar to tonic pupil ↓ Abnormal pupil never dilates	• Pupil doesnot constrict with 1% pilocarpine[Q] • Near reflex is Absent[Q] ↓ Differentiates from tonic pupil
Parinaud's (Dorsal Midbrain) Syndrome	Posterior Commissure		**Isocoria** Bilateral Dilated pupils	• Bilateral light reflex absent[Q] • Near reflex present[Q]	Associated with supranuclear upgaze palsy and retraction of upper eyelid (Collier's sign)

Pupils in Emergency Room

- Bilateral Constricted: Intrapontine Hemorrhage
- Bilateral Dilated: Tentorial herniation
- Anisocoria with affected pupil Dilated: 3rd CN palsy due to a herniated temporal lobe – Hutchinson's pupil

HIGH YIELD

Causes of Light Near Dissociation

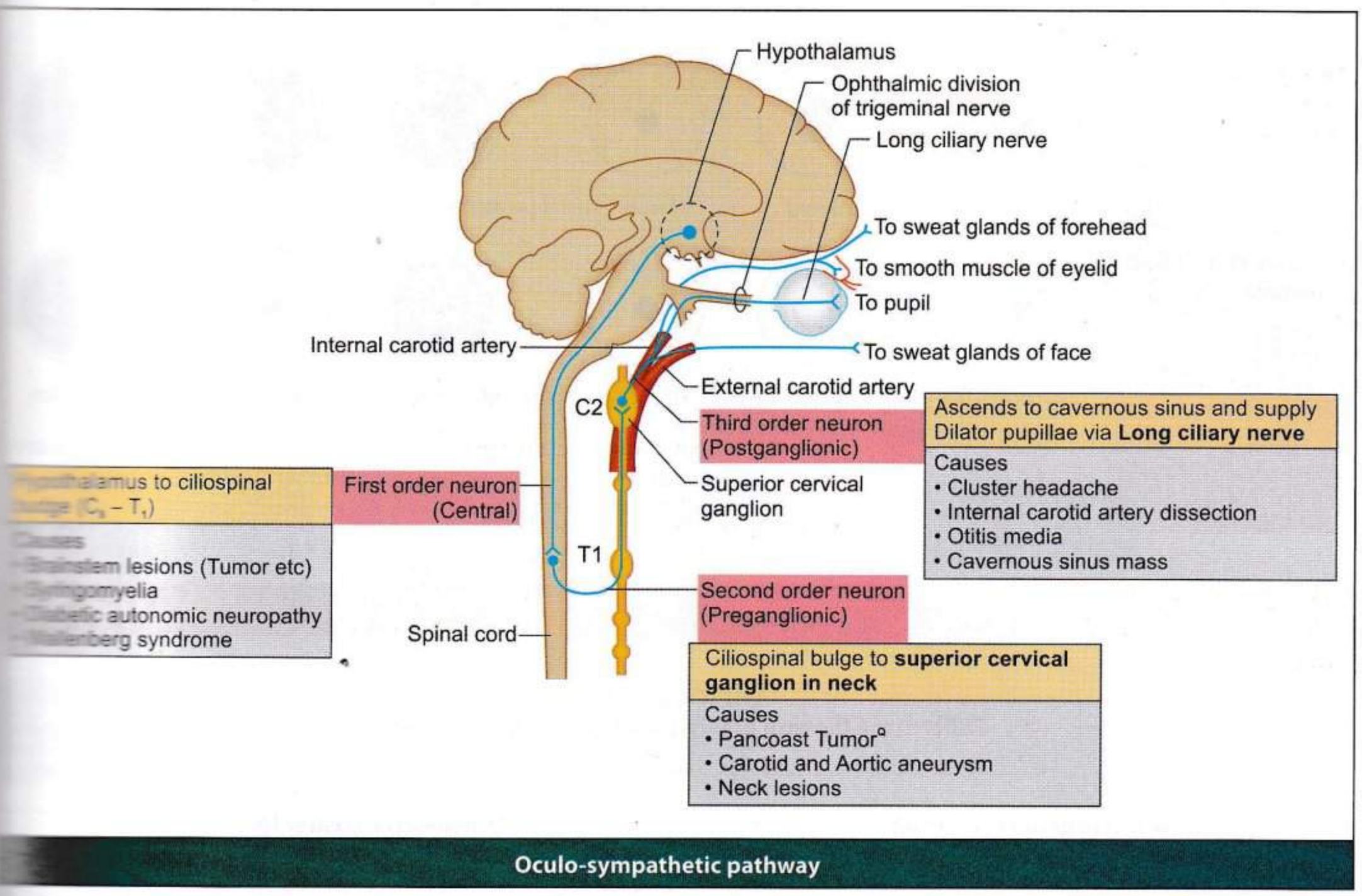
Unilateral	Bilateral

• Absolute afferent pathway defect (AAPD)
• Tonic/Adie Pupil
  ▪ Herpes zoster ophthalmicus
• Aberrant 3rd cranial nerve regeneration
	• ARP
	  ▪ Neurosyphilis
	  ▪ Encephalitis
	• Parinaud's (Dorsal Mibrain) Syndrome
	• Peripheral neuropathies
	  ▪ Type 1 diabetes
	  ▪ Chronic alcoholism
	  ▪ Familial Amyloidosis
	  ▪ Myotonic Dystrophy

Horner's Syndrome

We have read about pupillary defects arising from lesions of light reflex pathway and there by affecting function of sphincter pupillae (Parasympathetic supply)

Similarly, Dilator pupillae palsy (Sympathetic supply) can also lead to pupillary abnormalities by causing Horner's syndrome – **Oculosympathetic palsy**



Oculo-sympathetic pathway

Clinical Features

Mnemonic

Clinical Features – HI MAPLE

H – Hypochromic (lighter color) Heterochromia Iridis[Q] – Congenital cases
I – Inferior eyelid elevation - weakness of inferior Tarsal muscle
M – Miosis[Q] - palsy of Dilator pupillae - Anisocoria
A – Anhydroisis[Q] - Reduced ipsilateral sweating - Not seen in Post-ganglionic lesions
P – Ptosis[Q] - Weakness of Muller's[Q] muscle **Not LPS**
L – Loss of Ciliospinal[Q] reflex
E – Enophthalmos[Q] - Relative

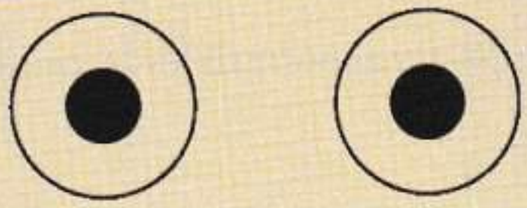
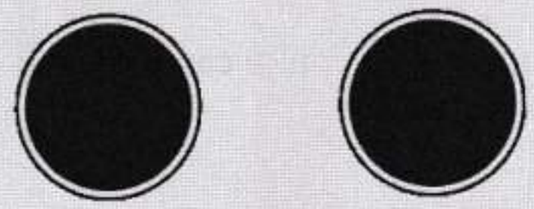
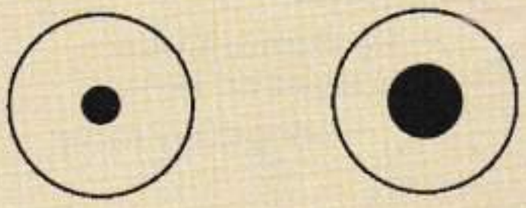
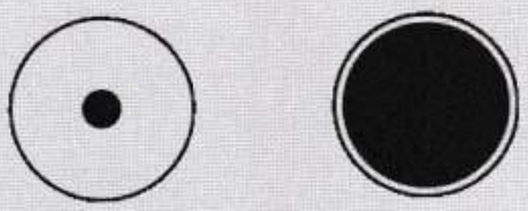
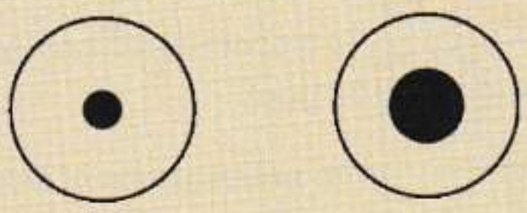
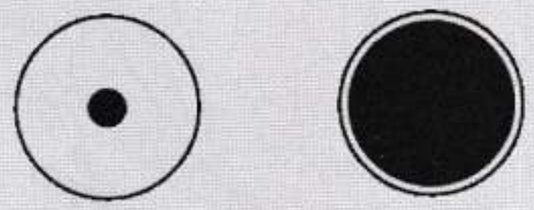
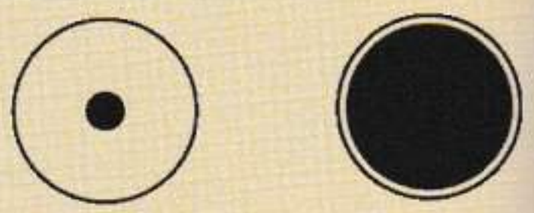
Pourfour de petit syndrome

This syndrome is the clinical **opposite** of Horner syndrome. It represents **oculosympathetic overactivity**.

Presents with mydriasis, eyelid retraction, exophthalmos and conjunctival blanching

Seen after Trauma, brachial plexus anaesthetic block and parotidectomy

Tests

	Before drops	4% Cocaine	1% Amphetamine
Normal pupils		 Both pupil dilate	Both pupil dilate
Central/Pre-Ganglionic Horner syndrome	 Horner pupil is constricted	 Horner pupil does **NOT**dilate	Both pupil dilate
Postganglionic Horner syndrome	 Horner pupil is constricted	 Horner pupil does **NOT** dilate	 Horner pupil does **NOT** Dilate
		Thus, Cocaine test Diagnoses Horner Syndrome	Thus, Amphetamine test Localizes Horner Syndrome as being pre-ganglionic/central

HIGH YIELD

Anisocoria

ANISOCORIA

Difference ≥ **0.4 mm** in pupil size between the two eyes

Anisocoria greater in DARK

Lesion/abnormal pupil is the constricted pupil (as the normal pupil is able to dilate in dark, where as abnormal pupil is not)

1% apraclonidine test

- Negative (neither pupil dilates) → Physiological anisocoria (i.e. anisocoria only in dark conditions)
- Positive (affected abnormal pupil dilates) → Horner's syndrome

Anisocoria greater in LIGHT

Lesion/abnormal pupil is the dilated pupil (as the normal pupilis able to constrict in light, but abnormal pupil is not)

- Abnormal pupil shape → Iris damage
- Normal pupil shape → Diluted pilocarpine (0.125%)
  - No constriction → Pilocarpine (1%)
    - Affected pupil constricts → 3rd nerve palsy
    - Neither pupil constricts → Pharmacological mydriasis
  - Affected /abnormal pupil constricts → Tonic pupil (Dennervation hypersensitivity)

COLOR BLINDNESS (DALTONISM)

Color blindness (DALTONISM)

Congenital

XLR[Q], thus, males[Q] affected more than females

Skips generations, from grandfather transfered to grandson

Acquired

Blue-yellow

- Retinal disease like CSR[Q], Macular edema **except** cone dystrophy and Stargarat's disease
- POAG

Red-Green[Q]

Optic nerve lesions like optic neuritis[Q], LHON **except** glaucoma

Blue blindness - old age

Dyschromatopsia

Achromatopsia

Dichromatic

Trichromatic anomalous

Rod monochromat

Cone monochromat

Perception of 1 color is absent - patient is blind for 1 color, patient can see 2(Di) colors

Perception of all 3(Tri) colors present but defective (Anomaly) for 1/2 colors

AR - with Total color blindness/day blindness

Only 1 color perception present (single color cone present)

Causes hemaralopia

[illegible]opia[Q] – Red color blind

[illegible]opia[Q] – Green color blind

[illegible]opia[Q] – Blue color blind

Protanomaly[Q] – Red color defect

Deutranomaly[Q] – Green color defect

Tritanomaly[Q] – Blue color defect

- Genes for Red and Green color are present on X chromosome (Xq 28) in a head to tail tandem array
- Genes for blue color on chromosome 7 – thus, **Tritanopia is inherited AD**.
- Most common color blindness
  - Deuteranomaly[Q]
  - Red-Green[Q] (in generic terms)
- Cones

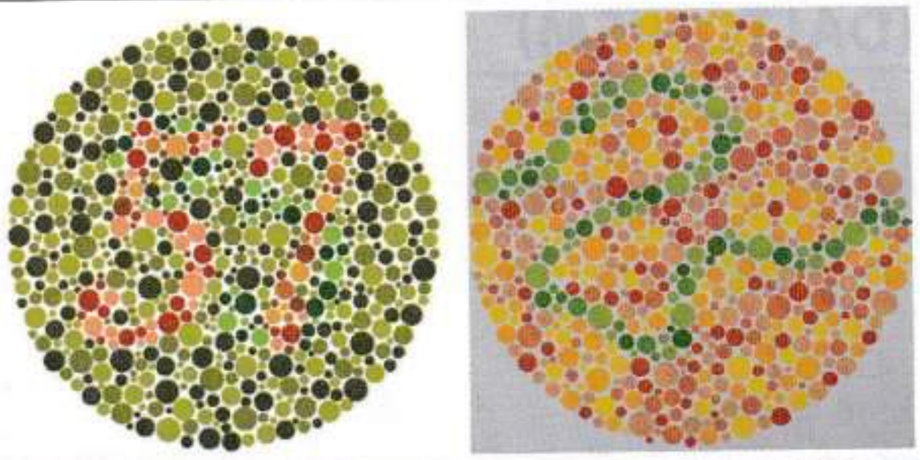
Mnemonic

Ram	–	Ⓡ	–	RED	→	PROTA	–	Ⓟ	–	Pehla Naam
Gopal	–	Ⓖ	–	GREEN	→	DEUTRA	–	Ⓓ	–	Doosra Naam
Berma	–	Ⓑ	–	BLUE	→	TRITAN	–	Ⓣ	–	Teesra naam

[illegible]cones	Short wavelength	420 nm	Blue color
[illegible]cones	Medium wavelength	530 nm	Green color
[illegible]cones	Long wavelength	560 nm	Red color

Tests for Color Vision

- [illegible]ihara Chart – [Q]Used to **screen for congenital Protan and Deutran** defects. Consists of 38 plates
- [illegible]y Rand **Rittler** - can detect all three congenital defects, especially useful in **pediatric age group** consists of 24 plates



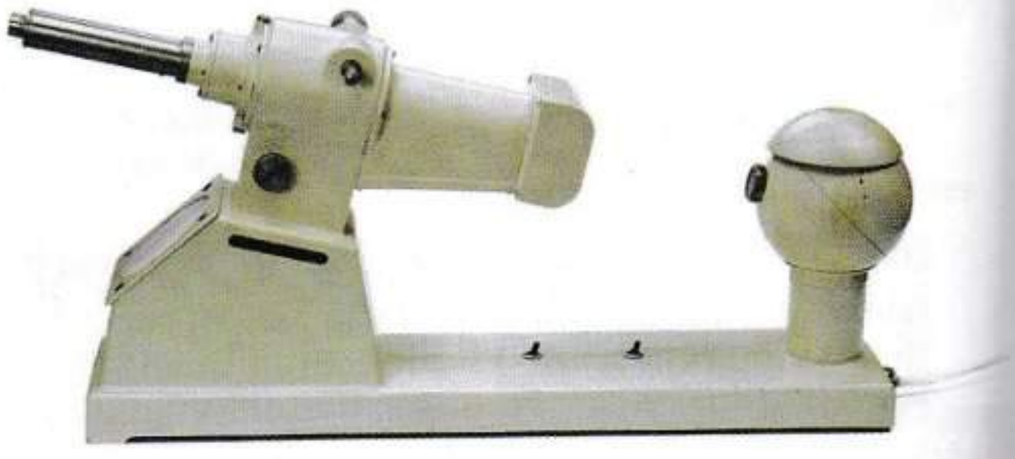
Ishihara chart plates

Hardy Rand Rittler test

Both these are Pseudo-isochromatic charts

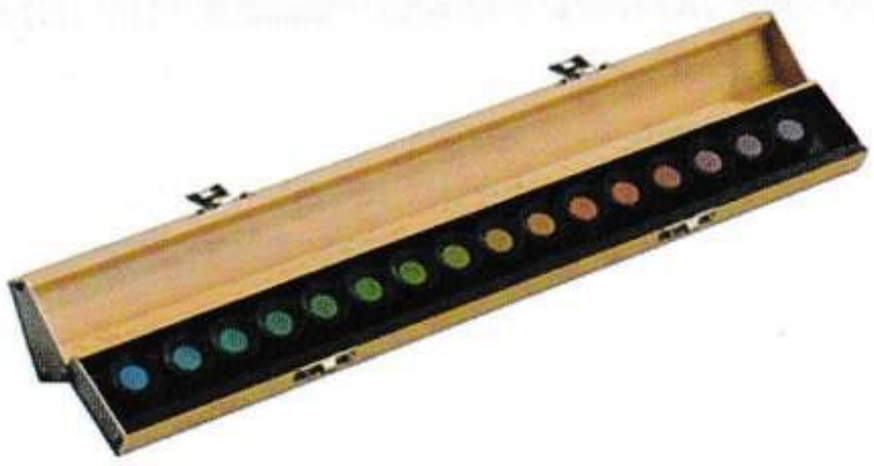
- **Lantern Test**—most commonly used for **vocational** testing such as for railway employees
- **Anomaloscope**—based on Rayleigh match. Most accurate to test the **severity** of color vision deficiency/blindness

Edridge-green lantern



Nagel's anomaloscope

- **Farnsworth Munsell D15 hue discrimination test**—very useful for distinguishing **congenital from acquired** color blindness, as it clearly shows Tritan (blue color) defects.
- **City University Test**—consists of 10 plates, where the central color needs to be best matched with the four peripheral colors.



FM 15 hue test

City university test

- **Holmgren's** wool test.
- **Farnsworth Munsell 100 hue test**- ^Q**Most sensitive test** for congenital and Acquired color defects
  An arrangement test with 85 hue caps.

EXTRA MILE

Drugs that cause color vision abnormalities:

Drug	Adverse effect
[illegible]	Transient blue-green color weakness
[illegible]	Yellow tinting of the vision – called xanthopsia
[illegible]	Red-green color blindness
[illegible]	Red-green defect

LAST MINUTE REVISION – ONE LINERS

[illegible]orbital optic nerve is the longest part of the optic nerve and Intraocular optic nerve is the smallest part of the optic nerve.

[illegible] nerve lesion – complete ipsilateral anopia, Earliest – Central scotoma, enlargement of blind spot (papilledema), [illegible]nal visual field defect (AION, glaucoma).

[illegible] chiasma lesion – Bitemporal hemianopia, Superior bitemporal heteronymous quadrantanopia (earliest VFD in [illegible] macroadenoma), Inferior bitemporal heteronymous quadrantanopia (earliest VFD in craniopharyngioma).

[illegible]nal scotoma is caused by lesion of Proximal optic nerve, Anterior knee of Von Willebrand.

[illegible]VFD below optic chiasm are Contralateral and Homonymous.

[illegible]'s pupil is seen in the lesion of Optic tract.

[illegible] shaped defects and Key hole shaped defects and sectoranopia are seen in incomplete lesions of LGB.

[illegible] defects are seen in lesions of visual cortex being supplied by the middle cerebral artery.

[illegible] in the sky – Temporal lobe optic radiations lesion.

[illegible] from the floor – parietal lobe optic radiations lesion.

[illegible] syndrome and Statokinetic dissocation (Riddoch phenomenon) are seen in cases of cortical blindness.

[illegible] evoked potential (VEP) is used to differentiate between organic and functional visual loss.

[illegible] Optic atrophy has chalky white disc with distinct margins.

[illegible]ary optic atrophy has dirty grey disc with indistinct margins.

[illegible] has mitochondrial inheritance causing bilateral, painless visual loss with peripapillary telangiectasia and [illegible]papilledema.

[illegible]edema is swelling of optic disc due to raised ICP.

[illegible] lines are seen in papilledema, with blurring of disc margins being the earliest sign.

[illegible] shining light onto one eye both pupil constrict, but both pupil donot constrict with shining light onto 2nd eye, I/L DLR [illegible]C L CLR absent – AAPD.

[illegible] shining light into eye, both pupil dilate – RAPD.

[illegible] pupil is always dilated – I/L tonic pupil.

[illegible] pupil non-reactive to light but constrict on near vision – ARP.

[illegible] does not constrict with near vision or with 1% pilocarpine – Pharmacological blockage.

[illegible]'s syndrome presents with Miosis in one eye (Anisocoria – which is more in dark as the affected pupil cannot dilate).

[illegible] in horner syndrome is not due to palsy of LPS, due to Muller's muscle palsy.

[illegible] colour blindness is most common in males as the most common mode of inheritance is XLR.

[illegible]worth –Munsell 100 hue test is the most sensitive test for detecting colour blindness.

[illegible] and Rittler test and Ishihara test are types of Pseudo-isochromatic charts.

IMAGE-BASED QUESTIONS

There are multiple probable questions that can be asked on a single image.
Question number 1 is based on Image 1.

Image 1

1. **Diagnose the pathology in the image.**
   a. Right Adie pupil
   b. Left Horner syndrome
   c. Argyll Robertson pupil
   d. Right 3rd cranial nerve palsy

Question number 2 is based on Image 2.

Image 2

2. **The patient in the image is most likely suffering from**
   a. Oculo-cutaneous Albinism
   b. Oculomotor nerve palsy
   c. Horner syndrome
   d. Ptosis

Question numbers 3 to 5 are based on Image 3.

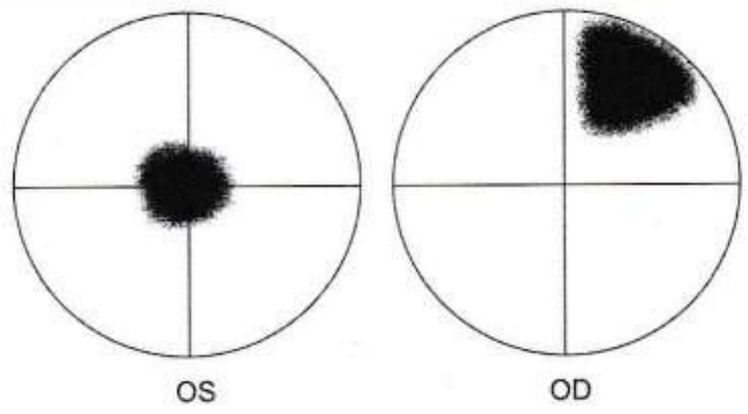


Image 3

3. **This Visual field defect may be caused by**
   a. Glaucoma
   b. Anterior ischemic optic neuropathy
   c. Olfactory groove meningioma
   d. Syphilitic meningitis

4. **Identify the visual field defect**
   a. Incongruous homonymous hemianopia
   b. Sparing of monocular temporal crescent
   c. Bilateral centrocecal scotoma
   d. Junctional scotoma

5. **What is the most likely site of lesion for the visual field defect?**
   a. Left Proximal optic nerve
   b. Left Distal optic nerve
   c. Left Macular retinal fibres
   d. Right temporal lobe

Question numbers 6 and 7 are based on Image 4.

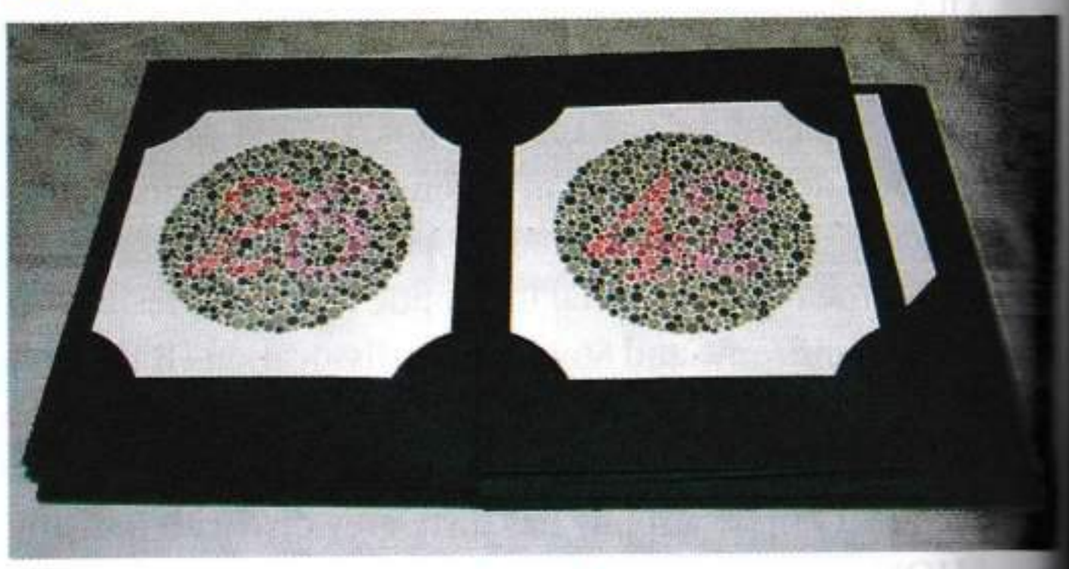


Image 4

6. **The above (image) instrument is used for testing of**
   a. Visual acuity for near
   b. Color vision
   c. Contrast sensitivity
   d. Dark adaptation

7. **Identify the instrument in the above image**
   a. Ishihara chart
   b. Farnsworth Munsell 26 hue test
   c. City University test
   d. Snellen chart

Question numbers 8 and 9 are based on Image 5.

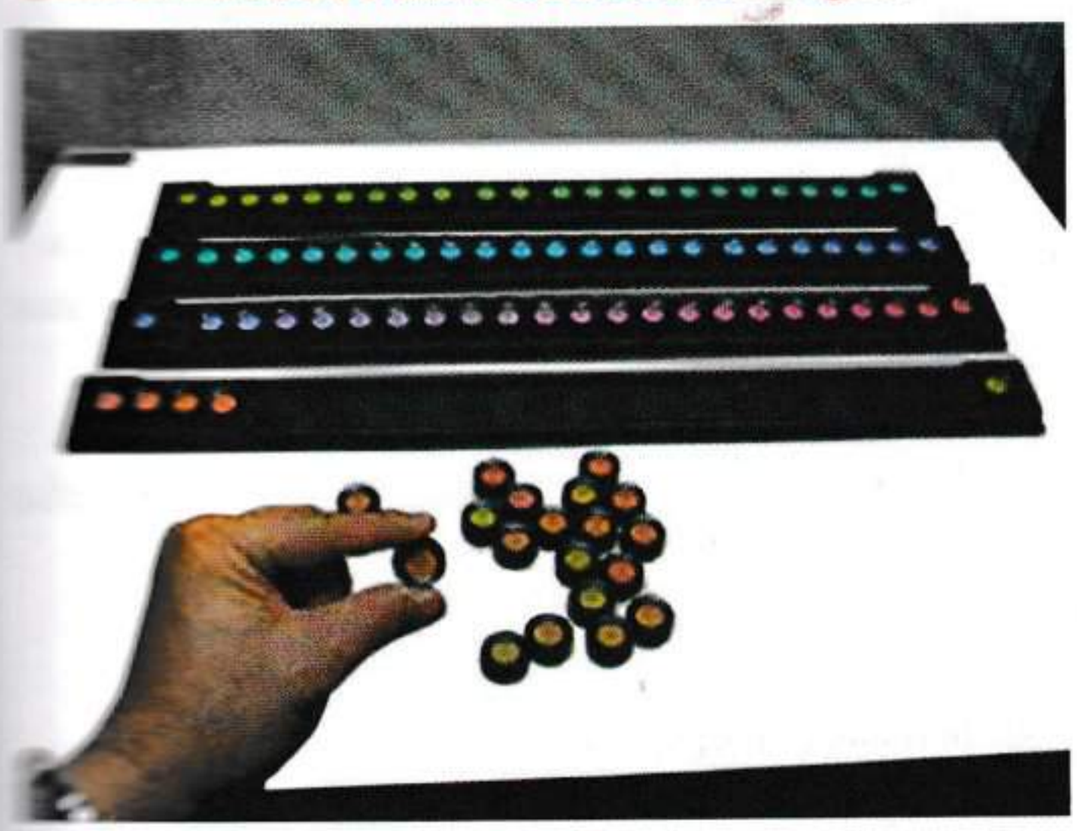


Image 5

8. Identify the test being undertaken by the patient in the above image *(Recent pattern DNB)*
   a. Ishihara chart test
   b. Jackson cross cylinder test
   c. Farnsworth-Munsell 100 hue test
   d. Pelli-robson charting
9. All of the following are true regarding the above test except
   a. It is the most sensitive test for congenital color blindness
   b. It is the most sensitive test for acquired color blindness
   c. It consists of 100 hue caps
   d. It can detect each of the three form of dichromatism

Question number 10 is based on Image 6.

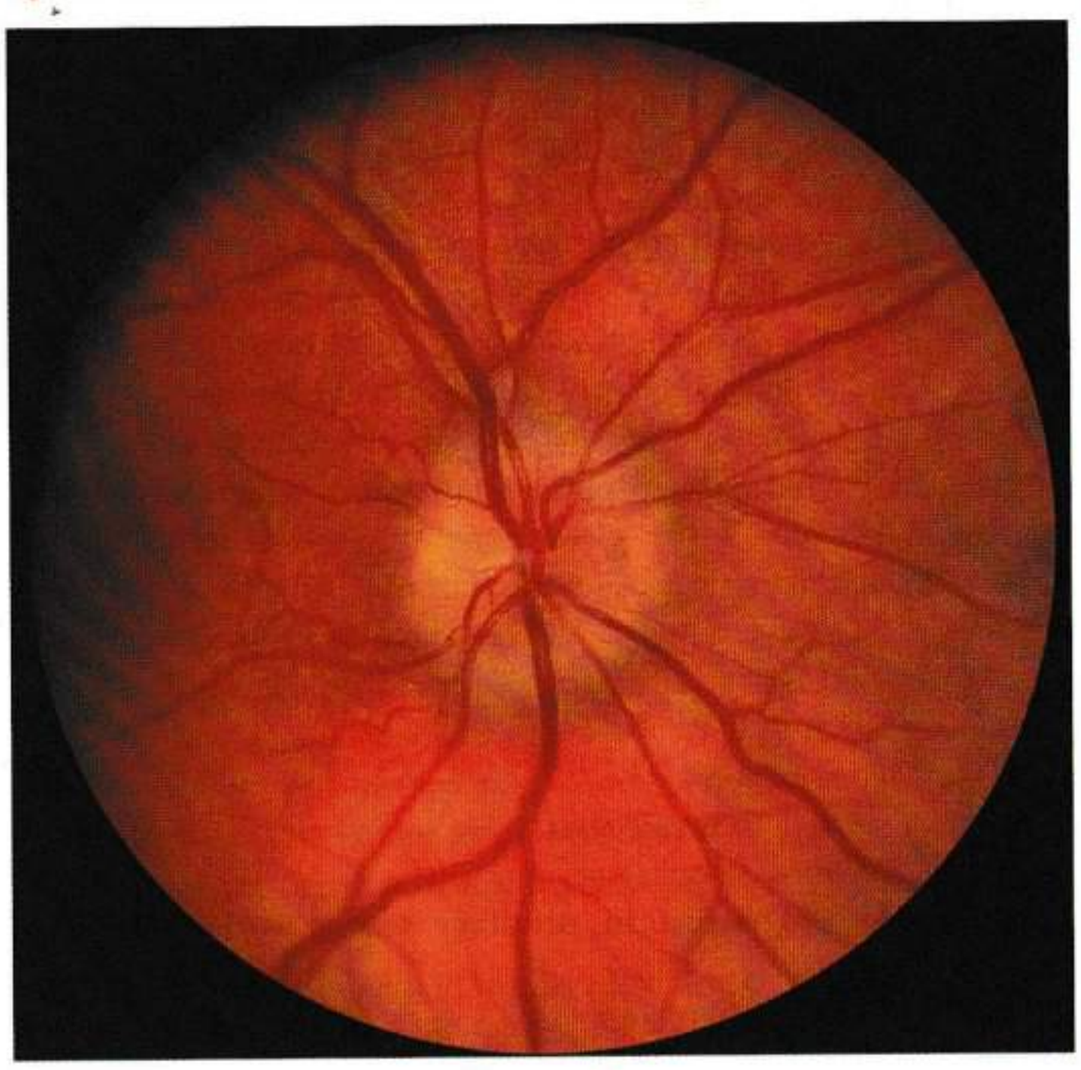


Image 6

10. Diagnose the ocular pathology.
    a. Primary optic atrophy
    b. Primary open angle glaucoma
    c. Papilledema
    d. Central retinal artery occlusion

MULTIPLE CHOICE QUESTIONS

Visual Pathway and Visual Field Defects

11. Which are first order neuron in optic pathway– *(Recent pattern Nov/Dec 2016)*
    a. Bipolar cell
    b. Ganglionic cells
    c. Cells of lateral geniculate body
    d. Photoreceptors
12. Optic nerve is – *(Recent pattern Nov/Dec 2016)*
    a. Second order neuron
    b. First order neuron
    c. Fourth order neuron
    d. Third order neuron
13. Lesion of optic tract causes? *(Recent pattern 2013)*
    a. Binasal hemianopia
    b. Bitemporal hemianopia
    c. Homonymous hemianopia
    d. Complete blindness
14. The parvocellular pathway from lateral geniculate nucleus to visual cortex is most sensitive for the stimulus of:
    a. Colour contrast
    b. Luminance contrast
    c. Temporal frequency
    d. Saccadic eye movements
15. The fibers from the contralateral nasal hemiretina project to the following layers of the lateral geniculate nucleus:
    a. Layers 2, 3 and 5
    b. Layers 1, 2 and 6
    c. Layers 1, 4 and 6
    d. Layers 4, 5 and 6
16. Right eye superotemporal quadrantopia, left eye centrocaecal scotoma with headache. Site of lesion is:
    a. Left optic nerve + chiasma
    b. Left optic tract + chiasma
    c. Right optic nerve + chiasma
    d. Right optic tract + chiasma
17. Keyhole shaped visual field defect is a feature of: *(AIIMS May 2016)*
    a. LGB
    b. Occipital lobe lesion
    c. Optic tract
    d. Optic radiations
18. Homonymous hemianopia is seen in all except –
    a. Optic nerve lesion *(Recent pattern Nov/Dec 2016)*
    b. Optic tract lesion
    c. Lesions of lateral geniculate body
    d. Visual cortex lesion

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19. Visual defect in optic chiasmal lesion– *(PGI May 2014)*

a. Bitemporal hemianopia
b. Binasal hemianopia
c. Homonymous upper temporal hemianopia
d. Homonymous upper nasal hemianopia
e. Homonymous lower temporal hemianopia

20. Altitudinal visual field defect is seen in –

a. Papilloedema *(Recent pattern Nov/Dec 2016)*
b. Retinitis pigmentosa
c. Anterior ischemic neuropathy
d. Buphthalmos

21. Headache with bitemporal hemianopia with 6/6 vision is seen in *(AIIMS Nov 2009)*

a. Optic neuritis b. Trauma
c. Chiasmal lesion d. Bilateral cavernous lesion

22. Scintillating scotoma is seen in:

a. Migraine
b. Hypertension
b. Transient ischemic attacks
d. Myasthenia gravis

23. Visual field defect in pituitary tumor with suprasellar extension is *(JIPMER 2011)*

a. Bitemporal hemianopia
b. Binasal hemianopia
c. Homonymous hemianopia
d. Altitudinal hemianopia

Pupillary Reflex

24. Which of the following is not a part of the pupillary reflex pathway? *(Recent pattern Nov/Dec 2016)*

a. Edinger Westphal nucleus
b. Medial geniculate body
c. Pretectal nucleus
d. Ganglion cells in the retina

25. Puppillomotor fibres of third cranial nerve travel alongwith: *(Recent pattern Nov 2015)*

a. Nerve to medial rectus
b. Nerve to superior rectus
c. Nerve to inferior rectus
d. Nerve to inferior oblique

26. All of the following statements about Argyll Robertson Pupil are correct, Except: *(All India 2011)*

a. Near Reflex Normal
b. Direct light Reflex Absent
c. Consensual Light Reflex Normal
d. Visual Acuity Normal

27. True about Argyll Robertson pupil: *(PGI Nov 2012)*

a. Seen in tertiary syphilis
b. Seen in Diabetes
c. Near reflex present, light reflex absent
d. Light reflex present, near reflex absent
e. Anisocoria

28. Argyll Robertson pupil is seen in *(Recent pattern Nov/Dec 2016)*

a. Tertiary syphilis b. Secondary syphilis
c. Primary syphilis d. Congential syphilis

29. Wernicke's hemianopic pupillary response is seen in lesions of *(Recent pattern 2015)*

a. Optic tract
b. Optic chiasma
c. Optic radiation
d. Lateral geniculate body

30. Swinging flash light test is positive in *(Recent pattern Nov/Dec 2016)*

a. Conjunctivitis b. Glaucoma
c. Retrobulbar neuritis d. Keratoconus

31. Marcus Gunn pupil is due to – *(Recent pattern Nov/Dec 2016)*

a. Total afferent pupillary defect
b. Relative afferent pupillary defect
c. Efferent pathway defect
d. Cerebral lesion

32. In Holmes-Adie pupil all are true except– *(Recent pattern 2016)*

a. There is absent or retarded pupil reaction to light and near
b. Most cases are bilateral
c. Causes reduced or absent accommodation
d. Constricts with 2.5% methacholine

33. A patient presented with normal eyesight and absence of direct and consensual light reflexes in left eye. Which of the following cranial nerves is suspected to be lesioned? *(Recent pattern Nov/Dec 2016)*

a. Occulomotor b. Trochlear
c. Optic d. Abducent

34. True statement regarding ciliary ganglion is/are: *(PGI May 2011)*

a. Situated b/w optic nerve & medial rectus tendon
b. Contain sensory fibre
c. Motor root arise from inferior oblique
d. Parasympathetic fiber- Edinger Westphal nucleus
e. Sympathetic nerve- supply sphincter pupillae

35. Which is/are true about anisocoria: *(PGI Nov 2012)*

a. Pupil at different level in the both eyes
b. Pupil of different size
c. Horner's syndrome can cause anisocoria
d. Pupil of different shape

36. In a case of anisocoria, when 1% pilocarpine is instilled into the eye with abnormally dilated pupil, no response occurs. Cause of anisocoria may be *(AIIMS Nov 2011)*

a. Adie's pupil
b. Horners syndrome
c. Pharmacological blockage
d. Uncal herniation

37. Hutchinson's pupil is:

a. Seen in syphilis
b. Non-reactive mydriatic pupil
c. Irregular pupil
d. Argyll Robertson pupil

38. Anisocoria in dim light is maximally seen in–

a. 3rd nerve palsy *(Recent pattern Dec 2012)*
b. Pharmacological mydriasis
c. Horner syndrome
d. Parasympathetic paralysis

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In RAPD, when light is moved from normal to affected eye, there is: *(AIPG 2010)*

a. Dilatation of both pupils
b. Constriction of both pupils
c. Dilatation in affected eye and constriction in normal eye
d. Dilatation in normal eye and constriction in normal eye

Cause(s) of mydriasis: *(PGI May 2016)*

a. Organophosphorus poisoning
b. Horner syndrome
c. Oculomotor nerve palsy
d. Parasympathetic stimulation

Mydriasis is/are caused by : *(PGI Nov 2011)*

a. Horner syndrome
b. Neurosyphilis
c. Organophosphorus poisoning
d. Opium
e. Atropine

Neutral density filter– *(Recent pattern Nov/Dec 2016)*

a. Amblyopia
b. Malingering
c. Afferent pupillary defect
d. Efferent pupillary defect

Horner's syndrome is characterized by all of the following except *(All India 2005)*

a. Miosis
b. Enopthalmos
c. Ptosis
d. Cycloplegia

Not a feature of Horner syndrome: *(PGI Nov 2011)*

a. Exophthalmos
b. Ptosis of upper eyelid
c. Miosis
d. Conjuctival congestion
e. Anhydrosis

Dilator pupillae is supplied by *(AIIMS Nov 2011)*

a. Post-ganglionic parasympathetic fibers from Edinger Westphal nucleus
b. Post-ganglionic sympathetic fibers from cervical sympathetic chain
c. IIIrd nerve
d. Sympathetic fibers from fronto-orbital branch of V nerve

Optic Atrophy/Optic Neuropathies

Optic atrophy is not seen in: *(Recent pattern 2013)*

a. Polypoidal choroidal vasculopathy
b. Retinitis pigmentosa
c. Methanol poisoning
d. Central retinal artery occlusion (CRAO)

Ophthalmolgy in a patient shows chalky white optic disc with well defined margins. Retinal vessels and surrounding Retina appears normal. Which of the following is the most likely diagnosis: *(All India 2012)*

a. Primary Optic Atrophy
b. Post-neuritic secondary optic atrophy
c. Glaucomatous optic atrophy
d. Consecutive optic atrophy

Which of the following vitamin deficiency can cause centrocecal scotoma: *(PGI Nov 2015)*

a. Vit A
b. Vit E
c. B6
d. B2
e. B12

49. True about Leber optic neuropathy: *(PGI May 2015)*

a. X-linked disease
b. Primarily affects male
c. Disc become pale & atrophic
d. Transmitted from mother to child
e. Mitochondrial inheritance

50. All of the following can cause Optic Neuritis, except– *(Recent pattern 2014)*

a. Rifampicin
b. Digoxin
c. Chloroquine
d. Ethambutol

51. A young man with blurring of vision in right eye, followed by left eye after 3 months, showing disc hyperemia, edema, circumpapillary telangiectasia with normal pupillary response with centrocecal scotoma on perimetry, the cause is – *(AIIMS May 2009)*

a. Typical optic neuritis
b. Acute Papilledema
c. Toxic optic neuropathy
d. Leber's hereditary optic neuropathy

52. Following are the clinical features of Leber optic neuropathy except – *(Recent pattern 2015)*

a. Seen in the 2nd or 3rd decade of life
b. It is an example of gradual painless visual loss
c. Males can transmit the disease
d. No leak of dye observed in fluorescein angiography

53. Which of the following statements regarding optic neuritis is false? *(Recent pattern 2015)*

a. Oral steroid therapy alone is contraindicated
b. MRI brain and orbit help to decide treatment
c. Steroids may help to decrease the duration of vision loss but do not affect the final visual outcome
d. Colour vision recovers faster than visual acuity

54. Wolfram syndrome is characterised by all except: *(Recent pattern 2016)*

a. Optic atrophy
b Diabetes mellitus
c. Diabetes insipidus
d. Parathyroid hyperplasia

55. Disc oedema is seen in: *(Recent pattern 2015)*

a. CRVO
b. CRAO
d. BRVO
d. BRAO

56. Unilateral vision loss with disc edema and macular star is seen in which of the following diseases? *(Recent pattern 2014)*

a. Hypertensive papilloedema
b. Papillophlebitis
c. Neuroretinitis
d. Glaucoma

57. A patient with sudden bilateral loss of vision with loss of light perception. The loss is more on right side. Pupillary reflex, optokinetic nystagmus are present. Patient can touch his fingers on closing his right eye. What is diagnosis? *(AIIMS 2011)*

a. Optic neuritis
b. Anterior ischaemic optic neuropathy
c. CMV retinitis
d. Functional vision loss

Most Recent Questions of 2019-2017 are given at the end

Papilledema

58. All statements are true about papilloedema except: *(All India 2007)*
a. Extracellular edema
b. Disruption of neurofilament
c. Stasis of axoplasmic flow
d. Axonal swelling

59. Which of following is a feature of papilloedema: *(PGI May 2013)*
a. Normal blind spot
b. Normal visual acuity even at last stage
c. Loss of venous pulsation at disc
d. Sluggish pupillary reaction from early stage
e. Normal colour vision

60. Earliest sign of papilloedema– *(Recent pattern 2015)*
a. Loss of pulsation
b. Blurring of disc margin
c. Obliteration of cup
d. Cotton-wool spots

61. Ispilateral optic atrophy with contralateral papilloedema is a feature of – *(Recent pattern 2013)*
a. Fischer syndrome
b. Foster kennedy syndrome
c. Vogt-kayanagi- Harada syndrome
d. WAGR syndrome

Colour Blindness

62. A person has defective blue colour appreciation. His condition is – *(Recent pattern 2013)*
a. Deuteranomalous
b. Deuteranopia
c. Tritanopia
d. Tritanomalous

63. Colour Blindness is most commonly seen in *(AIIMS May 2015)*
a. Males
b. Females
c. Equal incidence
d. No sex predilection

64. All of the following are true regarding tests for colour blindness except
a. Farnsworth D15 hue discrimination test can distinguish between hereditary and acquired colour blindness
b. Ishihara chart test cannot be used to detect Tritan defects
c. Hardy-Rand-Rittler test can detect all three congenital colour defects
d. Edridge-green lantern test is the best test

65. Which of the following statements is false regarding colour vision?
a. Colour vision begins in the retina with opponent colour coding in the ganglion cells
b. It is a subjective sensation
c. The genes for red and blue colour are arranged on q arm of the X chromosomes
d. In dim light all colours are seen as Gray

66. All of the following are tests for colour blindness except
a. Hardy-Rand-Rittler test
b. Holmgren's wool test
c. Lantern test
d. Goldmann-weekes test

67. A male patient presents to the physician's office to ask questions about color blindness. The patient is color-blind, as is one of his brothers. His maternal grandfather was color-blind, but his mother, father, daughter, and another brother are not. His daughter is now pregnant. What is the risk that her child will be color blind? *(JIPMER 2015)*
a. 100%
b. 50%
c. 25%
d. 12.5%

68. The frequency of colour-blind males is 1 in 100 in a certain population. What is the frequency of colour blind females given that the population is in Hardy-Weinberg equilibrium at this point?
a. 0.02
b. 0.0005
c. 0.01
d. 0.0001

69. A male patient, 28 years old, complaints of problem in colour perception due to which he couldnot get a job as a railway driver. On examination, he was diagnosed as being a Deutranomalous trichromat. He is suffering from *(AIIMS Nov 2004)*
a. Blue colour blindness
b. Green colour defect
c. Green colour blindness
d. Red colour defect

70. The colour best appreciated by the central cones of our foveo-macular area are:
a. Red and blue
b. Blue and green
c. Red and green
d. Blue and yellow

Miscellaneous

71. Lamina Cribrosa is not formed in which of the following condition: *(PGI May 2011)*
a. Iris coloboma
b. Nanophthalmia
c. Morning Glory Syndrome
d. Coloboma of retina
e. Optic nerve agenesis

72. Lamina cribrosa is absent in: *(All India 2007)*
a. Morning Glory syndrome
b. Nanophthalmia
c. Colobama of retina
d. Optic nerve agenesis

73. Oculogyric crisis is known to be produced by all of the following drugs except:
a. Trifluoperazine
b. Atropine
c. Perchlorperazine
d. Perphenazine

74. End organ for vision is– *(Recent pattern 2014)*
a. Bipolar cell
b. Ganglion cell
c. Rods and cones
d. Lateral geniculate body

75. Which of these ophthalmic manifestations is least likely due to acute meningococcal meningitis? *(Recent pattern 2015)*
a. Papilloedema
b. Cranial nerve palsy
c. Optic nerve palsy
d. Glaucoma

76. Charge syndrome includes all except: *(Recent pattern 2016)*
a. Coloboma
b. Heart defects
c. Urogenital anomalies
d. Esophageal atresia

Most Recent Questions of 2019-2017

77. Visual pathway defect at the level of optic chiasm will result in *(AIIMS May 2017)*
a. Binasal hemianopia
b. Bitemporal hemianopia
c. Central scotoma
d. Bilateral hemianopia

78. Pupil in a newborn is *(Recent pattern 2017)*
a. Constricted
b. Mid-dilated
c. Dilated
d. Any of the above

Most Recent Questions of 2019-2017 are given at the end

79. A 50-year-old male patient gives history of STD acquired 20 years back, now complaints of headache, seizures, confusion and numbness in extremities. Which of the following will be true about the pupillary response of the above patient? *(Recent pattern 2017)*

a. Light reflex and accomodation reflex absent
b. Light reflex and accomodation reflex present
c. Light reflex absent and accommodation reflex present
d. Light reflex present and accommodation reflex absent

80. All are true about optic nerve except: *(Recent pattern 2017)*

a. Arises from axons of bipolar neurons
b. 4 cm long
c. Covered by 3 layers continuous with meninges
d. Crossed by ophthalmic artery

81. Which one of the following is an oculotoxic drug? *(AIIMS Nov 2018)*

a. Isoniazid
b. Ethambutol
c. Streptomycin
d. Rifampin

82. A patient presents with Right homonymous hemianopia. Most likely site of lesion is *(Recent question June 2018)*

a. Left optic radiation
b. Right geniculate body
c. Right optic nerve
d. Right optic radiation

83. Most common ocular sign of Myasthenia Gravis? *(Recent question 2019)*

a. Ptosis
b. Proptosis
c. Diplopia
d. Lagophthalmos

ANSWERS TO IMAGE-BASED QUESTIONS

1. Ans. (a) **Right Adie pupil**

Case of **Anisocoria** (unequal pupil size), **with either right pupil abnormal as dilated** or **left pupil abnormal as constricted**

Option b – seems likely as Left horner syndrome will cause left miosis, but unlikely without ptosis being seen

Option c – Bilateral small, irregular pupil – No anisocoria

Option d – Mydriasis of right eye will be seen due to palsy of sphincter pupillae but associated Ptosis must also be seen.

2. Ans. (c) **Horner syndrome**

In the image Ptosis (drooping of the upper eyelid) along with Miosis (constriction of pupil) can be seen in the left eye

Option a – white hair, pale skin and pink eye appearance due to iris translucence

Option b – Ptosis with **Mydriasis** in the affected eye

Option c – Ptosis with **Miosis** in the affected eye, may be associated with hypochromic heterochromia iridis.

3. Ans. (c) **Olfactory groove meningioma**

4. Ans. (d) **Junctional scotoma**

5. Ans. (a) **Left Proximal optic nerve**

In the image, left visual field shows a central scotoma along with an incomplete superotemporal quadrantanopia in the right eye.

Such a defect is known as a **Junctional scotoma** – affecting the left optic nerve and the right anterior knee of Von Willebrand (inferonasal fibers – form a loop into the opposite optic nerve before passing into the opposite optic tract) – leading to left anopia – which starts from the centre as a central scotoma, as macular fibres are most sensitive to damage and progresses to complete anopia and right superotemporal quadrantanopia.

The **most common cause of Junctional Scotoma** – lesion at proximal Optic nerve or Anterior knee of Von willebrand **is Meningioma** (tuberculum sella > olfactory groove).

6. Ans. (b) **Color vision**

7. Ans. (a) **Ishihara chart**

Ishihara chart – used to screen for congenital protan and deuteran defects

It consists of 34 test plates.

There exist **four different types of plates:**

- ***Vanishing design:*** Only people with good color vision can see the sign. If you are colorblind you won't see anything.
- ***Transformation design:*** Colorblind people will see a different sign than people with no color vision handicap.
- ***Hidden digit design:*** Only colorblind people are able to spot the sign. If you have perfect color vision, you won't be able to see it.
- ***Classification design:*** This is used to differentiate between red- and green-blind persons. The vanishing design is used on either side of the plate, one side for deutran defects and the other for protans.

8. Ans. (c) **Farnsworth-Munsell 100 hue test**

9. Ans. (c) **It consists of 100 hue caps**

Option a / b – it is the most sensitive test for both congenital and acquired colorblindness.

Option c – despite the name 100 hue, it consists of 85 hue caps.

Option d – Dichromatism (absence of one type of cone), can be detected by this test, as it can detect all three types of color defect/blindness.

10. Ans. (c) **Papilledema**

Option a – should be a pale – white disc.

Option b – POAG should present with loss of nasal neuro-retinal rim and Cupping (large cup, c/d ratio >0.5) along with vascular changes.

Option d – CRAO – no occlusion can be seen, all arteries (thinner cross-section, red colour) and veins (thicker cross-section, darker red color) are seen to be patent.

Option c – Papilledema – earliest sign is blurring of the disc margins, which is visible in the image.

Most Recent Questions of 2019-2017 are given at the end

ANSWERS TO MULTIPLE CHOICE QUESTIONS

11. Ans. (d) Photoreceptors

Ref: Snell's Clinical Neuroanatomy 7/e, p. 337; Moore's Anatomy 7/e, p. 1063

12. Ans. (d) Third order neuron

This is a point of contention between opthalmology books and anatomy books. But as all standard anatomy books maintain the same, for MCQ's we will consider
1st order neurons – Rod and cones
2nd order neurons – Bipolar cells
3rd order neurons – Ganglion cells/Optic nerve

13. Ans. (c) Homonymous hemianopia

Ref: Khurana 5/e, p. 60; Kanski 7/e, p. 827.

14. Ans. (a) Colour contrast

Ref: Ganong's 22/e, p. 160-161

Pathway of color vision passes from the X ganglion cells through the parvocellular layer of the LGB to the layer IV C of the visual cortex.

15. Ans. (c) Layers 1, 4 and 6

Ref: Khurana Anatomy 2/e, p. 161

LGB: 1, 4 6 has contralateral supply, whereas 2, 3 5 has ipsilateral supply

16. Ans. (a) Left optic nerve + chiasma

Ref: Kanski 7/e, p. 826-827

This type of field defect is seen in meningiomas where the lesion is at the **junction of optic nerve and the chiasma**. This is called "**junctional scotoma** of Traquair". (VFD No. 3–Text)

17. Ans. (a) LGB

Ref: Walsh & Hoyt's clinical neurology, p. 98

Keyhole shaped scotoma is a feature of incomplete LGB lesion.

18. Ans. (a) Optic nerve lesion

Ref: Khurana 4/e, p. 290-291

19. Ans. (a) Bitemporal hemianopia; (b) Binasal hemianopia

Ref: Kanski 7/e, p. 816–826

- Heteronymous as both eyes lose visual field of respective side, from left eye can't look left and from right eye can't look right side—optic chiasma lesion.
- Homonymous – post chiasmatic lesions

20. Ans. (c) Anterior ischemic neuropathy

Ref: Parson's 22/e, p. 522, 355

21. Ans. (c) Chiasmal lesion

Ref: Parson's, 22/e, p. 507-509

May be seen in chaismal lesions caused by 3rd ventricular glioma leading to raised ICP.

22. Ans. (a) Migraine

Ref: Parson's 22/e, p. 95

Migraine can be preceded by visual aura, seen as scintillating scotomata.

23. Ans. (d) Bitemporal hemianopia

Ref: Parson's, 22/e, p. 509

Early loss in lower half of fields suggests a suprasellar tumors.

24. Ans. (b) Medial geniculate body

Ref: Kanski 7/e, p. 812; Parson's 22/e, p. 34

25. Ans. (d) Nerve to inferior oblique

Ref: Kanski 7/e, p. 812

26. Ans. (c) Consensual Light Reflex Normal

Ref: Kanski 7/e, p. 815

ARP—Accommodation Reflex present (Part of Near reflex)
PRA—Pupillary light reflex absent (both DLR and CLR)

27. Ans. (a) Seen in tertiary syphilis; (c) Near reflex present, light reflex absent

Ref: Khurana 5/e, p. 313

- ARP is caused by neurosyphilis.
- *Tertiary* syphilis, includes cardiovascular syphilis, gummatous syphilis, and *neurosyphilis.*
- Miotic and irregular pupils, usually **bilateral pupil involvement but asymmetrical** (but not Anisocoria as per definition is difference ≥ 0.4 mm). Light reflex is absent or very sluggish.

28. Ans. (a) Tertiary syphilis

Ref: Kanski 7/e, p. 815

29. Ans. (a) Optic tract

Ref: Kanski 7/e, p. 828

30. Ans. (c) Retrobulbar neuritis

Ref: Parson's, 22/e, p. 122

Swinging flash light test is used to check RAPD, which may be the earliest finding in optic neuritis.

31. Ans. (b) Relative afferent pupillary defect

Ref: Parson's, 22/e, p. 122; Kanski 7/e, p. 812

- Marcus Gunn pupil is seen in **relative afferent pathway defect (RAPD).**

32. Ans. (b) Most cases are bilateral

Ref: Kanski 7/e, p. 815

- Typically affects young adults and presents as **unilateral condition in 80% cases**
- DLR and CLR are absent

- Near reflex is blow (sluggish)
- As there is defect in post-ganglionic para-sympathetic innervation to eye, i.e., there is deficiency of parasympatholytic system, the pupil will react when even a minimum concentration of parasympathomimetic drugs (e.g. 0.125% pilocarpine, 2.5% methcholine) is given.

Ans. (a) Oculomotor

Ref: Kanski 7/e, p. 815

In complete optic nerve lesion of one side (afferent pupillary defect)

- The **ipsilateral** direct reflex is absent
- The **contralateral** consensual reflex is absent

In oculomotor nerve lesion of one side (efferent pupillary defect)

- The **ipsilateral** direct reflex is absent
- The **ipsilateral** consensual reflex is absent

Ans. (b) (Contain...); (c) (Motor...) and (d) (Parasympathetic...)

Ref: BDC 4/e Vol. III p. 114-15,293; Gray's 40/e, p. 669

Correlate Box

The **ciliary ganglion** is a *parasympathetic*[Q] ganglion located in the posterior orbit.

It lies near **the apex of the orbit** between the *optic nerve and the tendon of the lateral rectus muscle.*

In classical anatomy, the ciliary ganglion is said to have **three "roots"**

- A **parasympathetic root** *of ciliary ganglion (or motor root)*
  - *The motor root arises from the nerve to the inferior oblique. It contains preganglionic fibers that begin in the Edinger Westphal nucleus. This supply the sphincter pupillae and the ciliaris muscle.*
- A **sympathetic root** of ciliary ganglion
  - *The sympathetic root is a branch from the internal carotid plexus. This supply the blood vessels of the eyeball & also supply the dilator pupillae.*
- A **sensory root** *of ciliary ganglion*
  - *The sensory root comes from the nasociliary nerve*

Ans. (b) Pupil of different size; (c) Horner's syndrome can cause anisocoria

Ref: Khurana 5/e, p. 313

"Anisocoria is a condition, defined as a difference of 0.4 mm or more between eye's pupils"

- Afferent pathway defects have isocoria
- Efferent pathway defects present with anisocoria

Ans. (c) Pharmacological blockage

Ref: Kanski 7/e, p 815

37. Ans. (b) Non-reactive mydriatic pupil

Ref: Parson's 22/e, p. 532; Manual of neuro-ophthalmology — Amar agarwal p. 63

Unilateral, **Non-reactive dilated pupil** due to 3rd CN palsy caused by uncal herniation—usually seen in **comatose pateints**.

38. Ans. (c) Horner syndrome

Refer text

39. Ans. (a) Dilatation of both pupils

Ref: Parson's 22/e, p. 122

40. Ans. (c) Oculomotor nerve palsy

Ref: Khurana 6/e, p. 504; Parson's 22/e, p. 32; PK Mukherjee 161

41. Ans. (e) Atropine

Ref: Khurana 4/e, p. 474; Parson's 20/e, p. 492; Reddy 27/e, p. 458

42. Ans. (c) Afferent pupillary defect

Ref: Essentials of ophthalmology p. 53

"Neutral density filters can be used to grade the severity of afferent pupillary defect"—Essentials of ophthalmology

43. Ans. (d) Cycloplegia

Ref: Kanski 7/e, p. 814

44. Ans. (a) Exophthalmos; (d) Conjuctival congestion

Ref: Harrison 18/e, p. 225; Khurana 6/e, p. 379; Parson's 22/e, p. 122.

45. Ans. (b) Post-ganglionic sympathetic fibers from cervical sympathetic chain

Ref: AK Khurana 6/e, p. 147

46. Ans. (a) Polypoidal choroidal vasculopathy

Ref: Parson's 21/e, p. 355; Kanski 6/e, p. 787, 788, 643

47. Ans. (a) Primary Optic Atrophy

Ref: Kanski 7/e, p. 790

Chalky white optic disc with well defined margins is typical of primary optic atrophy.

48. Ans. (d) B2, (e) B12

Ref: Kanski 7/e, p. 800-801, Yanoff 4/e, p. 890

49. Ans. (b) Primarily affects male, (d) Transmitted from mother to child, (e) Mitochondrial inheritance

Ref: Khurana 5/e, p. 316; Parson's 22/e, p. 368

50. Ans. (a) Rifampicin

Ref: Kanski 5/e, p. 601, 603

- Important drugs causing optic neuritis are quinine, ***chloroquine, ethambutol, isoniazid (INH)***, Streptomycin, ***Digoxin***, Amoidarone, NSAIDs (aspirin, indomethacin, phenylbutazone, ibuprofen), vigabatrine, disulfiram).

51. Ans. (d) Leber's hereditary optic neuropathy

Ref: Yannof & Ducker 3/e, p. 976; Parson's 20/e, p. 348

- Hypermic disc, **Telengiectasia**, centrocecal scotoma which is bilateral is characteristic for LHON.

52. Ans. (c) Males can transmit the disease

Ref: Kanski 7/e, p. 799; Parson's 22/e, p. 368

53. Ans. (d) Colour vision recovers faster than visual acuity

Ref: Parson's 22/e, p. 361-362

54. Ans. (d) Parathyroid hyperplasia

Ref: Kanski 7/e, p. 800; Parson's 22/e, p. 368

55. Ans. (a) CRVO

Ref: Parson's 22/e, p. 350

Swollen optic disc or disc oedema – causes

Unilateral

- **Papillitis** or optic neuritis involving the nerve head (sudden loss of vision with subsequent improvement young age)
- **Anterior ischaemic optic neuropathy** (sudden loss of vision usually without improvement old age)
- **Orbital tumours** (slowly progressive visual loss)
- **Papillophlebitis** or optic disc vasculitis (rapid loss of vision without improvement)
- **Central retinal vein occlusion**[Q] (may or may not be associated with profound visual impairment)
- Infiltrative disorders (impaired vision)
- **Ocular hypotony** (rapid loss of vision without improvement)
- Foster-Kennedy syndrome (true papilloedema in one eye with optic atrophy in the fellow eye)
- Pseudo Foster-Kennedy syndrome
- Posterior uveitis and scleritis

Bilateral

- Increased intracranial pressure: papilloedema (optic nerve function is typically normal)
- Hypertension (optic nerve function is typically normal)
- Diabetic papillopathy (mild-to-moderate impairment of vision)
- Cavernous sinus thrombosis
- Carotid-cavernous fistula
- Leber hereditary optic neuropathy in the acute stage
- Other systemic diseases such as anaemia and hypoxaemia

56. Ans. (c) Neuroretinitis

Ref: Kanski 7/e, p. 791

Macular star can be seen in:

- **Hypertensive retinopathy** (Macular star with disc edema, Cotton wool spots and flame hemorrhage)
- **Papilledema** (No visual loss until optic atrophy occurs and **B/L**)
- Anterior ischemic optic neuropathy
- Diabetic papillopathy
- Toxic etiologies, including bis-chloroethyl, nitrosourea and procarbazine.
- Solitary idiopathic choroiditis
- Acute multifocal retinitis (Disc edema is frequent, macular star in few cases)
- Idiopathic retinal vasculitis, aneurysms and neuroretinitis syndrome
- Lyme disease and cat-scratch disease are important causes of optic neuritis associated with macular star formation.
- **Neuroretinitis**

57. Ans. (d) Functional vision loss

Ref: Parson's 21/e, p. 94, 95, 96

- Sudden visual loss rules out CMV retinitis
- Presence of pupillary reflex indicates unimpaired lower visual pathway, thus rules out optic neuritis and AION (optic nerve lesion)
- **Positive Finger-finger test** suggests functional vision loss
  - In finger-finger test, the patient is instructed to touch the right finger tip with the left with eyes open. **Even a truly blind person would able to perform this task, since proprioception is intact; but a patient with functional visual loss will feign an inability to do this**
  - Finger test is negative in lesions of cerebellum
- **"Functional" visual loss/non-organic visual loss is a subjective complaint of impaired vision without any demonstrated organic or objective basis**. Nonogranic visual loss falls into one of **two categories– conversion reaction (hysterical blindness) or malingering**

Conditions which produce visual loss with a normal fundus– Differential diagnosis of Functional visual loss

Amblyopia	May suddenly notice poor vision in one eye though the onset is usually in early childhood. It is important to identify an amblyopiogenic factor such as aniosmetropia, Manifest squint, microtropia, etc
Cortical blindness	Must be ruled out by a detailed history, careful observation and examination of the patient with relevant investigations
Retrobulbar neuritis	A definite or relative afferent pupillary defect will be present
Cone-rod dystrophy	Positive family history, photophobia in bright light, abnormal dark adaptation and abnormal cone dystrophy electroretinogram
Chiasmal tumour	Sometimes visual loss may precede optic atrophy. Pupils show a sluggish reaction to light, with characteristic visual field defects

58. Ans. (b) Disruption of neurofilament

Ref: Parson's 22/e, p. 351

59. Ans. (c) Loss of venous pulsation at disc

- Visual failure occurs **late** with secondary optic atrophy- *Kanski 7/e, p. 802*

- Patient may describe constriction of visual field, **dyschromatopsia**, diplopia–*Yanoff 4/e, p. 876.*

68. Ans. (b) Blurring of disc margin

Ref: Clinical ophthalmology 2/e, p. 349; Parson's 22/e, p. 352

69. Ans. (b) Foster kennedy syndrome

Ref: Kanski 7/e, p. 796; Parson's 22/e, p. 350

70. Ans. (d) Tritanomalous

Ref: Khurana Anatomy 2/e, p. 244; Parson's 22/e, p. 90

71. Ans. (a) Males

Ref: Khurana Anatomy 2/e, p. 244

72. Ans. (d) Edridge-green lantern test is the best test

Ref: Kanski 7/e, p. 651

73. Ans. (c) The genes for red and blue colour are arranged on q arm of the X chromosomes

Ref: Khurana Anatomy 2/e, p. 237-244

Option a – colour vision is a function of cones, but its neural processing begins in the retina at the level of ganglion cells (W, X and Y cells). Some of the ganglion cells are excited by one colour type cone and inhibited by other i.e **Opponent colour coding**

Option b – Fact

Option c – Genes

- Human rhodopsin – chromosome 3
- Blue sensitive cone – chromosome 7
- Red and green sensitive cone – tandem array arrangement on the q arm of the X chromosome

Option d – In dim light, all colours are seen as gray, this is called the **Purkinje shift phenomenon.**

74. Ans. (d) Glodmann-weekes test

Ref: Kanski Anatomy 7/e, p. 651; Ref: Khurana Anatomy 2/e, p. 245

75. Ans. (c) 25%

Colour blindness is inherited mostly as an X-linked recessive disorder.

Now, it becomes a simple genetics question.

His daughter has got one mutant allele from him and is thus, a female carrier

Now the probability her child will be colour blind is

P1 = chance of having a son 2/4=1/2

P2 = chance of female carrier transmitting the mutant allele to the son = ½

$$P=P1 \times P2 = \frac{1}{4} = 25\%$$

76. Ans. (d) 0.0001

The frequency of colour blindness is equal to the frequency of colour blind males, as colour blindness is an XLR condition.

Thus, it is 0.01

In females, to be colour blind, both alleles have to be mutant, thus 0.01 x 0.01 = 0.0001

69. Ans. (b) Green colour defect

Ref: Khurana Anatomy 2/e, p. 244

70. Ans. (c) Red and green

The very centre of the fovea is blue blind.

71. Ans. (c) Morning Glory Syndrome

Ref: Morning Glory syndrome – A Histopathological study British Journal of ophthalmology; The Morning Glory syndrome' Ophthalmologica 1983; 187(7) : 222 – 230 1990, 74; 56-58

Lamina Cribrosa is absent in ***Morning Glory syndrome***

The aetiology of the disorder remains controversial, although it would appear to be related to an isolated *coloboma of the optic nerve.*

Lamina Cribrosa is a sieve like perforation in the posterior part of the sclera that allows passage of the retinal ganglion cell axons and central retinal vessels.

It is the weakest part of the sclera.

72. Ans. (a) Morning Glory syndrome

Ref: Morning Glory syndrome– A histopathological study British Journal of ophthalmology; the morning Glory syndrome' Opthalmologica 1983; 187 (7): 222-230 1990, 74; 56-58

73. Ans. (b) Atropine

Ref: Drug induced ocular side effects by Fraunfelder 7/e, p. 112

It is a spasmodic conjugate movement of eyes along with the synergic movement of head and neck. It occurs due to **phenothiazine idiosyncrasy**.

74. Ans. (c) Rods and cones

Ref: Sunita Agrawal 2/e, p. 309

- *"The end organ of the visual pathway is the neural epithelium of rods and cones"*

75. Ans. (d) Glaucoma

Ref: Walsh & Hoyt's 6/e, p. 2598

Neuro-ophthalmic manifestations of Acute bacterial meningitis

- Multiple cranial neuropathies, particularly ocular motor nerve paresis occurs most common is Abducens nerve paresis
- Papilledema
- Optic atrophy
- Cortical blindness

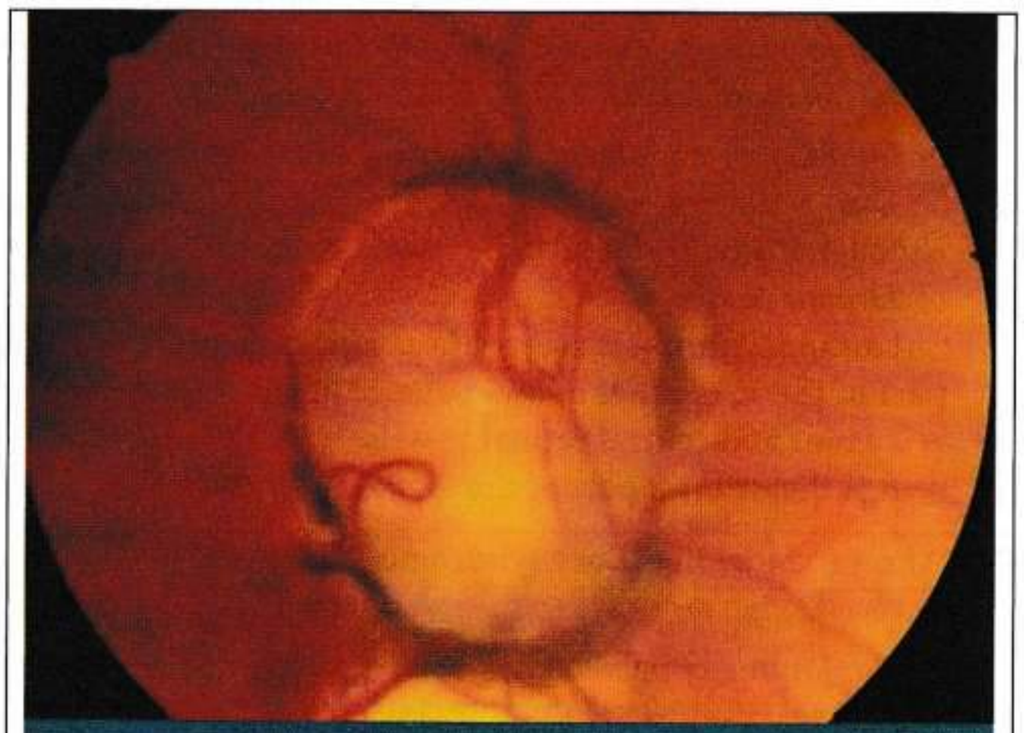
76. Ans. (d) Esophageal atresia

Ref: Yanoff and Duker 4/e, p. 872; Kanski 7/e, p. 806

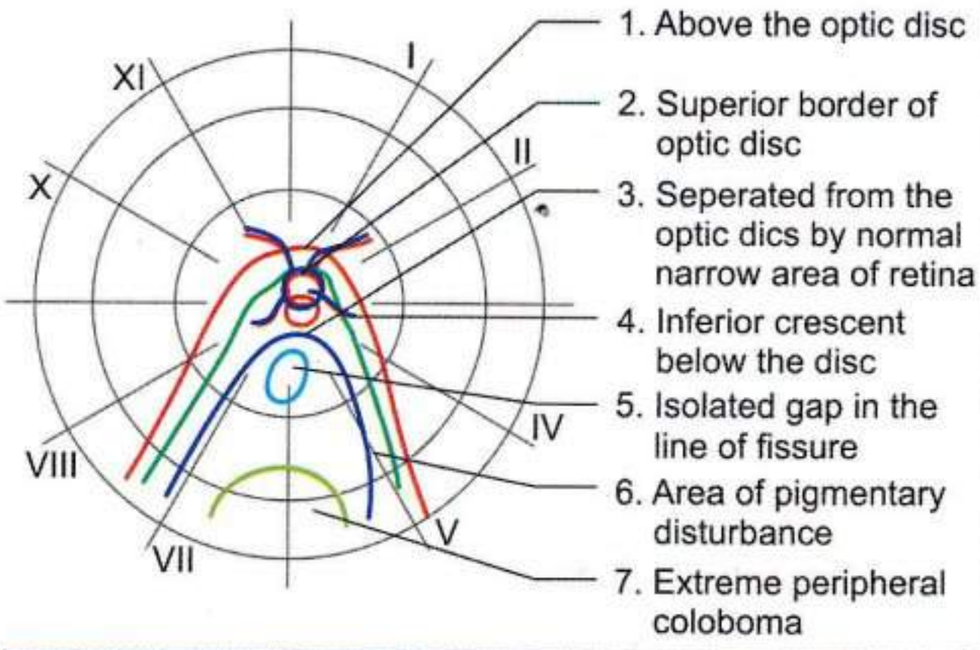
Systemic associations of optic disc coloboma

- Papillorenal syndrome–AD–renal and urinary tract malformations with retinochoroidal and optic disc coloboma, morning glory syndrome, retinal detachment
- Patau syndrome (Trisomy 13)
- Edwards syndrome (Trisomy 18)
- Cat-eye syndrome (Trisomy 22)
- **CHARGE syndrome**[Q]—Coloboma, heart defects, choanal atresia, retarded growth, ear anomalies

- Central nervous system anomalies.
- Walker-warburg syndrome
- Goldenhar's syndrome
- Linear sebaceous nevus
- Dandy-Walker syndrome
- Optic nerve colobomas typically involve the inferior part of the nerve, superior rim is usually spared.



Inferior rim Optic disc coloboma with normal vasculature



Ida- mans classification for choroidal coloboma

77. (b) Bitemporal hemianopia

Ref. Kanski's 8/e, p. 820

78. Ans. (a) Constricted

Ref: Clinical Paediatrics by Chatterjee, p. 39

Pupils of newborn infants are Constricted - 2 to 4 mm till about 3 weeks of age

79. Ans. (c) Light reflex absent and accommodation reflex present

Ref: Kanski 7/e, p. 815

STD with neurpsychiatric symptoms hints towards patient having Neurosyphilis.

Argyll Robertson pupil is seen in Neurosyphilis, which presents with

- Irregular, small pupil in dim light
- In bright light, neither pupil constricts (Light reflex absent)
- On accommodation both pupil constrict (Accomodation reflex absent)

80. Ans. (a) Arises from .... & (b) 4 cm long

Ref: Khurana Anatomy 2/e, p. 140-152

Each ***optic nerve*** (second cranial nerve) starts from the optic disc and extends up to optic chiasma, where the two nerves meet. It is the backward continuation of the nerve fibre layer of the retina, which consists of the *axons originating from the ganglion*[Q] *cells.* It also contains the afferent fibres of the pupillary light reflex.

47-50 mm in length

Meningeal sheaths. Pia mater, arachnoid and dura covering the brain are continuous over the optic nerves[Q].

81. Ans. (b) Ethambutol

Ref: Parson's 22/e, p. 244, 366; Kanski 7/e, p. 868)

Visual symptoms or toxic optic neuropathy occurs more commonly if dose exceeds 25 mg/kg/day. Patient experiences red-green colour blindness and blurring

82. Ans. (a) Left optic radiation

Ref: Khurana 6/e, p. 314

Just remember – Homonymous is always Contralateral and all in lesions below optic chiasma.

83. Ans. (c) Diplopia

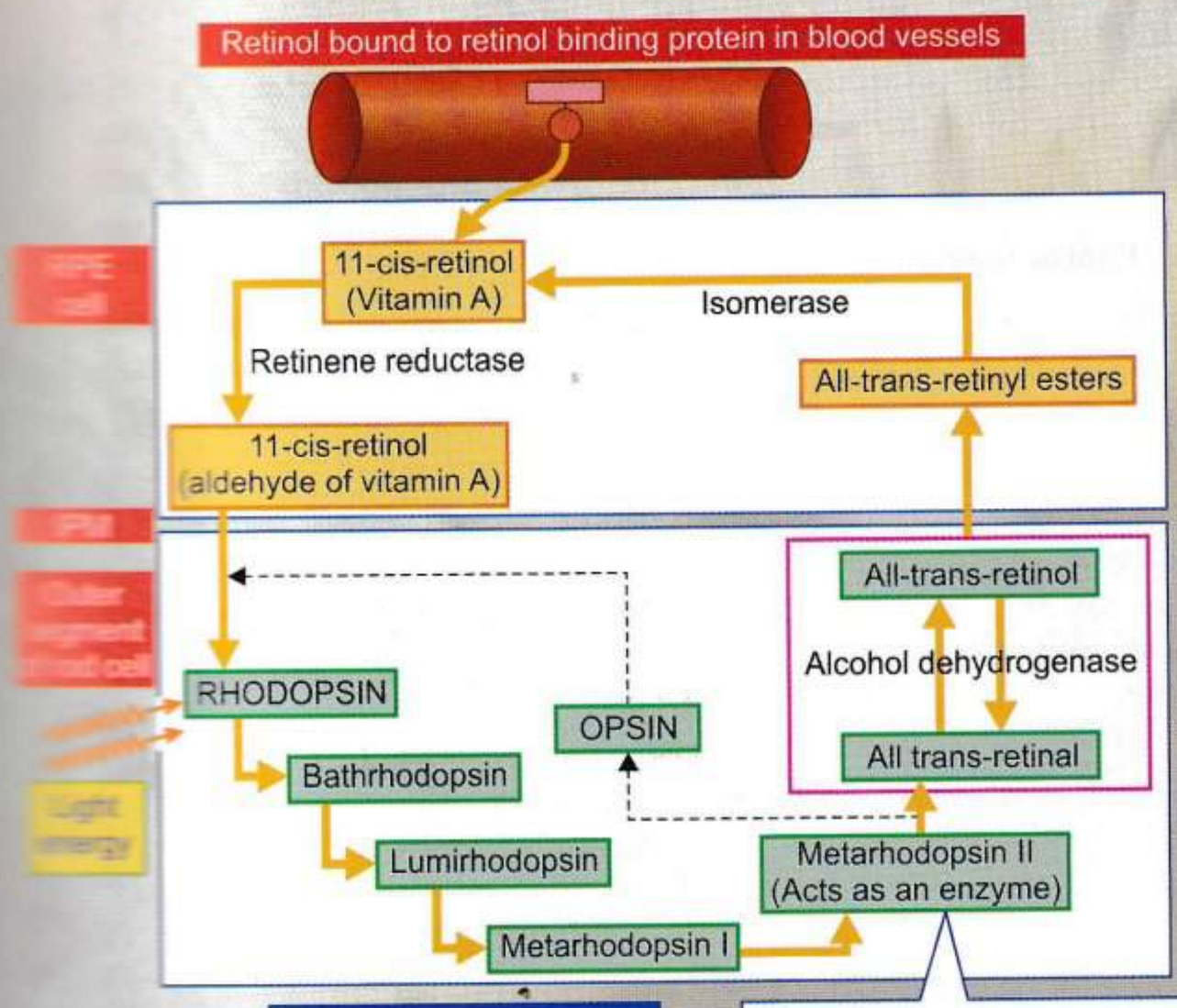
Ref: Kanski 7th/850

The most common clinical manifestation of MG is Diplopia found in 90% cases either with (60%) or without (30%) ptosis.

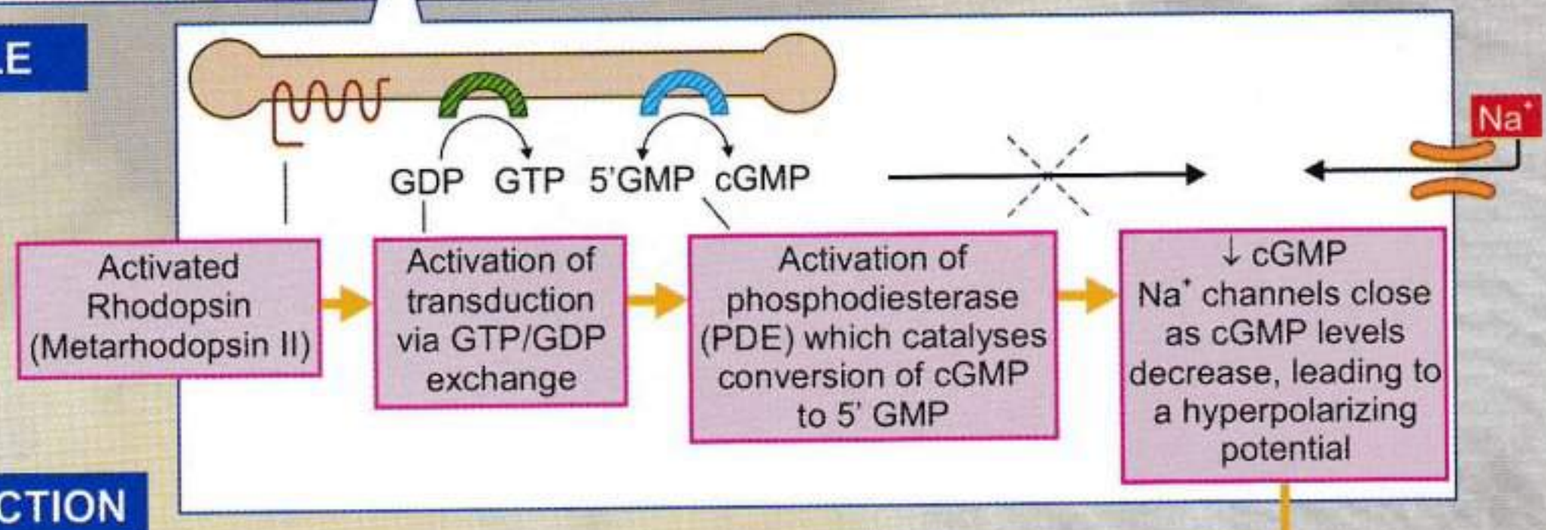
BONUS PAGE 3

PHYSIOLOGY OF VISION

VISUAL CYCLE



PHOTOTRANSDUCTION


GDP GTP 5'GMP cGMP
Na+
Activated Rhodopsin (Metarhodopsin II)
Activation of transduction via GTP/GDP exchange
Activation of phosphodiesterase (PDE) which catalyses conversion of cGMP to 5' GMP
↓ cGMP
Na+ channels close as cGMP levels decrease, leading to a hyperpolarizing potential

Receptor potential generated in the photoreceptors is a local graded potential (NOT Action potential) and is transmitted by electronic conduction to bipolar cells and then to GANGLION CELLS

X-cells	Y-cells
Project via optic nerve to layers 3–6 of LGB – PARVOCELLULAR	Project to layer 1 & 2 of LGB – MAGNOCELLULAR
Transmits color vision and also conveys point-to-point spatial information, fine detail	Detects rapid motion, flicker and depth
Superficial layer 4C of visual cortex	Deep layer 4C of visual cortex

BONUS PAGE 4

LASERS IN OPHTHALMOLOGY

- LASER stands for light amplification by stimulated emission of radiation
- Lasers may be used to deliver energy in PULSED form (milliseconds to microseconds), Quality switched or Q-switched (very short pulses, 5-100 nanoseconds) or continuous wave form.
- Types and Uses

Photoablation	Photocoagulation	Photodisruption
Chemical effect	Thermal effect	Ionizing + Chemical + Mechanical effect
Works by vaporizing the tissue – by breaking the chemical bonds	Works by causing denaturation of proteins	Works by stripping electrons from their nuclei, producing PLASMA like matter, and generating mechanical acoustic shockwaves (Miniature light bolt and thunder clap)
Excimer (Excited Dimer) laser – most commonly used is Argon Fluoride (ArF) – 193 nm	Argon green laser – 514 nm Diode laser – 810 nm Frequency doubled – 532 nm Nd: YAG laser Ruby red laser – 694 nm	Nd: YAG laser – 1064 nm Nd: Glass laser – 1053 nm (Femtosecond laser)
Ultraviolet radiation wavelength is used	Visible spectrum wavelength of light used	Wavelength of lasers causing ablation is beyond the visible spectrum, i.e. INFRARED, thus a helium-neon or diode laser beam is used for focusing
Used in corneal refractive procedures like PRK & LASIK	Used for retinal photo-coagulation in CRVO, Macular edema, Diabetic retinopathy and in Laser Trabeculoplasty for POAG	Used for posterior capsulotomy in PCO and Peripheral iridotomy in PACG

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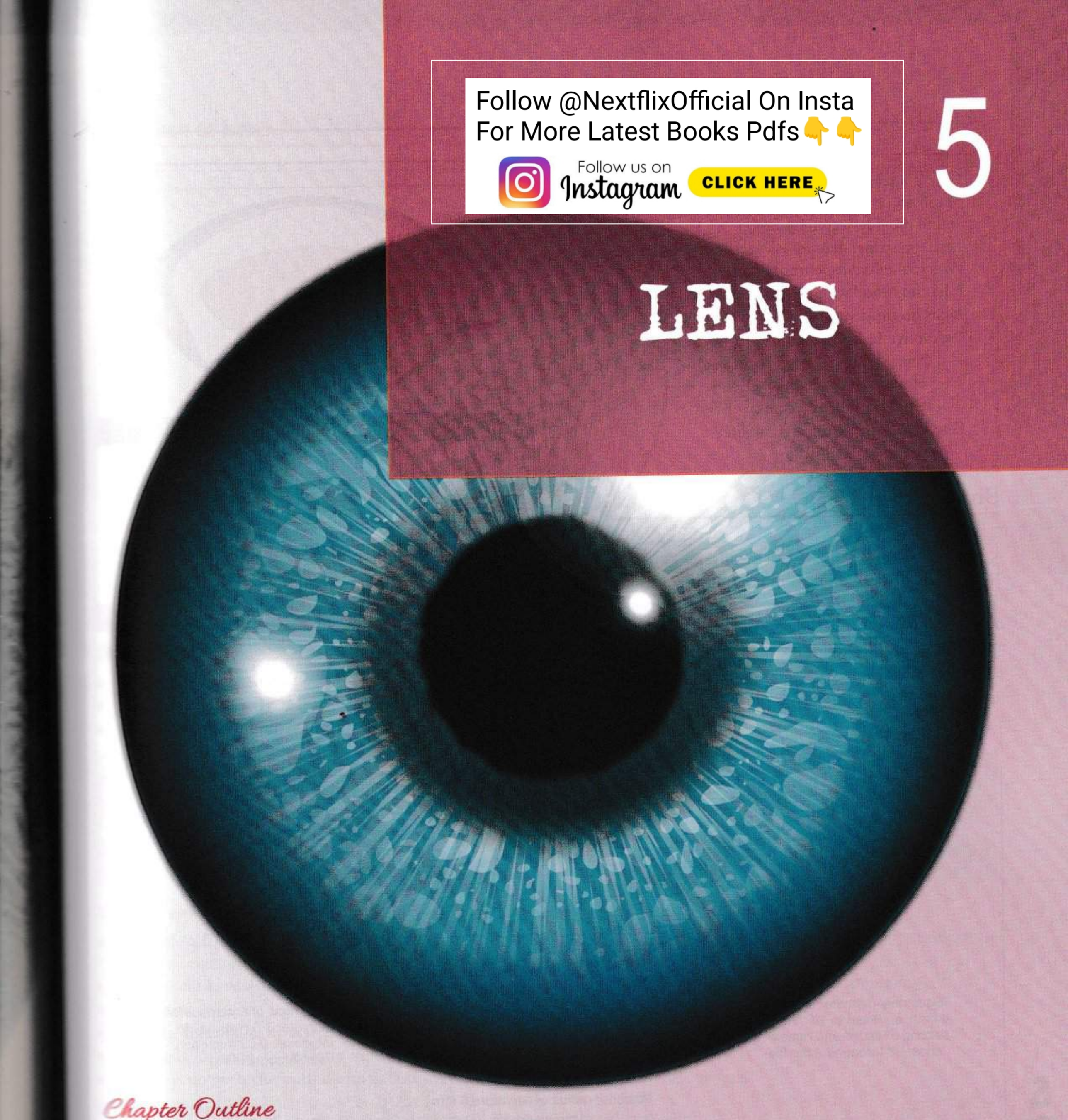
5

LENS



Chapter Outline

Anatomy
Physiology
- Proteins
- Metabolism

Acquired Cataract
- Senile
- Metabolic
- Miscellaneous

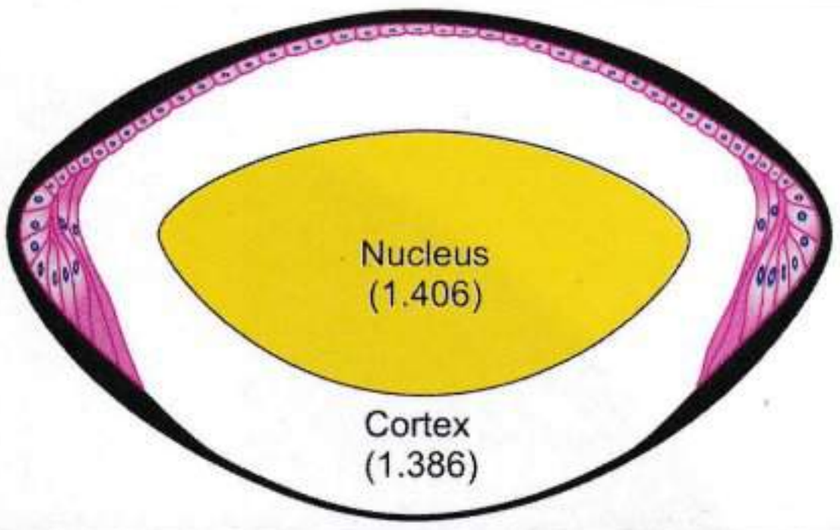
Congenital Cataract

Management of Cataract
- Surgeries

Ectopia Lentis
Microspherophakia
Lenticonus

"The future is an opaque mirror.....
We don't see things as they are, we see them as we are."

- Lens is a **transparent** structure in the eye with functions of refraction of light (+16D to +19D converging power) and to provide accommodation.
- Lens is suspended in its position–**Patellar Fossa**–by ciliary zonules/suspensory ligament
- It has **no blood supply**[Q]
- It has **no innervation**
- **Refractive Index of lens**
  - Centre of lens (nucleus)—1.406[Q]—(Highest refractive index in eye)
  - Periphery of lens (cortex)—1.386
- Lens grows in size throughout life[Q]



Refractive index of lens

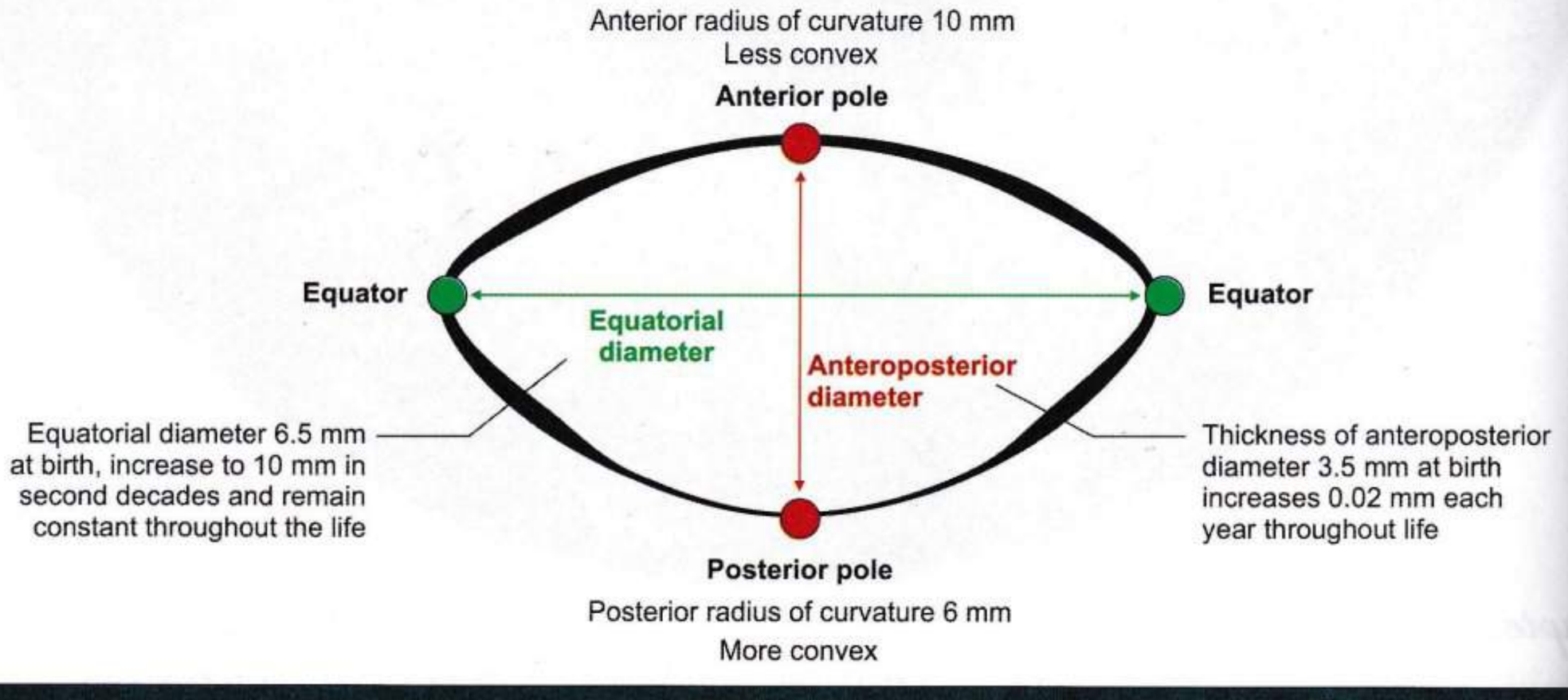
Shape of Lens

Biconvex
(nonsymmetric ablate spheroid)

Anterior surface	Posterior surface
10 mm radius of curvature – less curved	6 mm radius of curvature – **more curved**

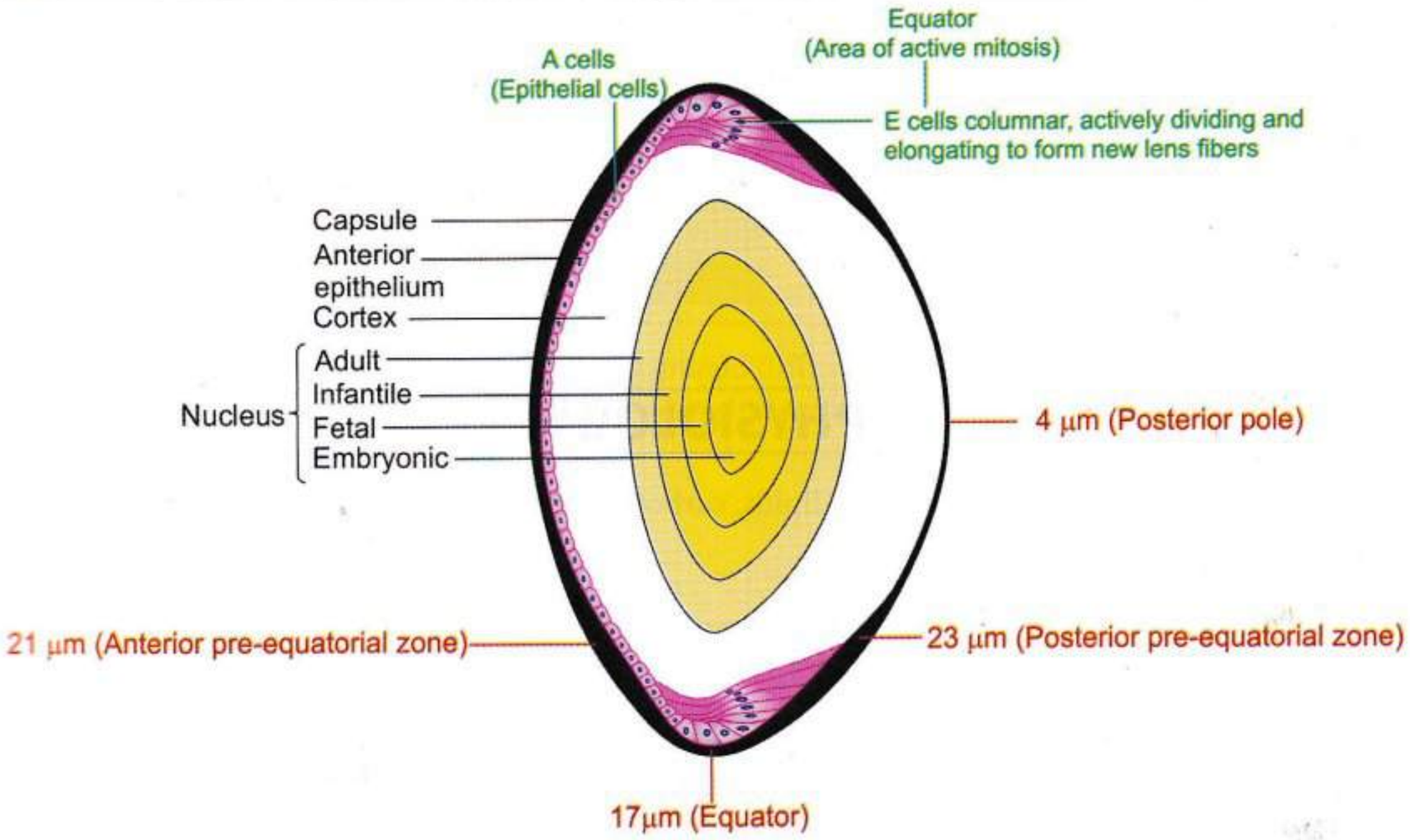
EXTRA MILE

- Posterior surface of lens is attached to the anterior hyaloid face (vitreous) in a circular area by **Weigert's ligament**
- **Berger space/Retrolental space** – a potential cavity between attachment of lens and vitreous


Anterior radius of curvature 10 mm
Less convex
Anterior pole
Equator
Equatorial diameter
Anteroposterior diameter
Equator
Equatorial diameter 6.5 mm at birth, increase to 10 mm in second decades and remain constant throughout the life
Thickness of anteroposterior diameter 3.5 mm at birth increases 0.02 mm each year throughout life
Posterior pole
Posterior radius of curvature 6 mm
More convex

Shape of lens

...ture of Lens



Structure of lens (Red color – thickness of capsule)

...most layer—capsule

- It is the thickest **Basement membrane** in the body, laid down by epithelial cells of lens.
- It is made of **Type IV** collagen.Q
- Anterior capsule is three times thicker than the posterior capsule

Capsule **thinnest at** Posterior Pole[Q]	Capsule **thickest** at Posterior Pre-equatorial Area

...mentions thickest capsule as anterior pre-equatorial, but as mentioned above and seen in the image, Posterior pre-equatorial is ...er by 2 μm—Source: American Academy of Ophthalmology

...erior epithelium of lens

- A single cell layer of **cuboidal cells** in the central zone which become columnar, actively dividing cells in the germinal zone near the equator
- These cells have a **unique EFCI**-epithelial fiber-cell interface, i.e. apical fibers, helping in transcytotic processes
- Epithelial cells lack Tight junctions/zona occludens
- It is the **metabolically active** layer of lens
- Epithelial cell nuclei at equator have a characteristic "Nuclear Bow" configuration
- There is **no posterior epithelium** as it forms primary lens fibers during embryogenesis.

...ortex

- Both contain lens fibers which are formed by equatorial epithelial cells
- The oldest fibers are present in central (embryonic) nucleus.Q
- New fibers laid down form the outermost cortex

...cleus

- Nucleus **consists of four zones/regions**
  - Embryonic nucleus—formed by fibers laid down from 1st–3rd month of gestation. Contains the **oldest** lens fibers.
  - Fetal nucleus—from 3rd–8th month of gestation
  - Infantile nucleus—from birth till puberty
  - Adult nucleus—formed after puberty. Contains the **youngest** lens fibers.

Sutures in Lens

Form in the fetal period and thus seen in the **fetal nucleus**

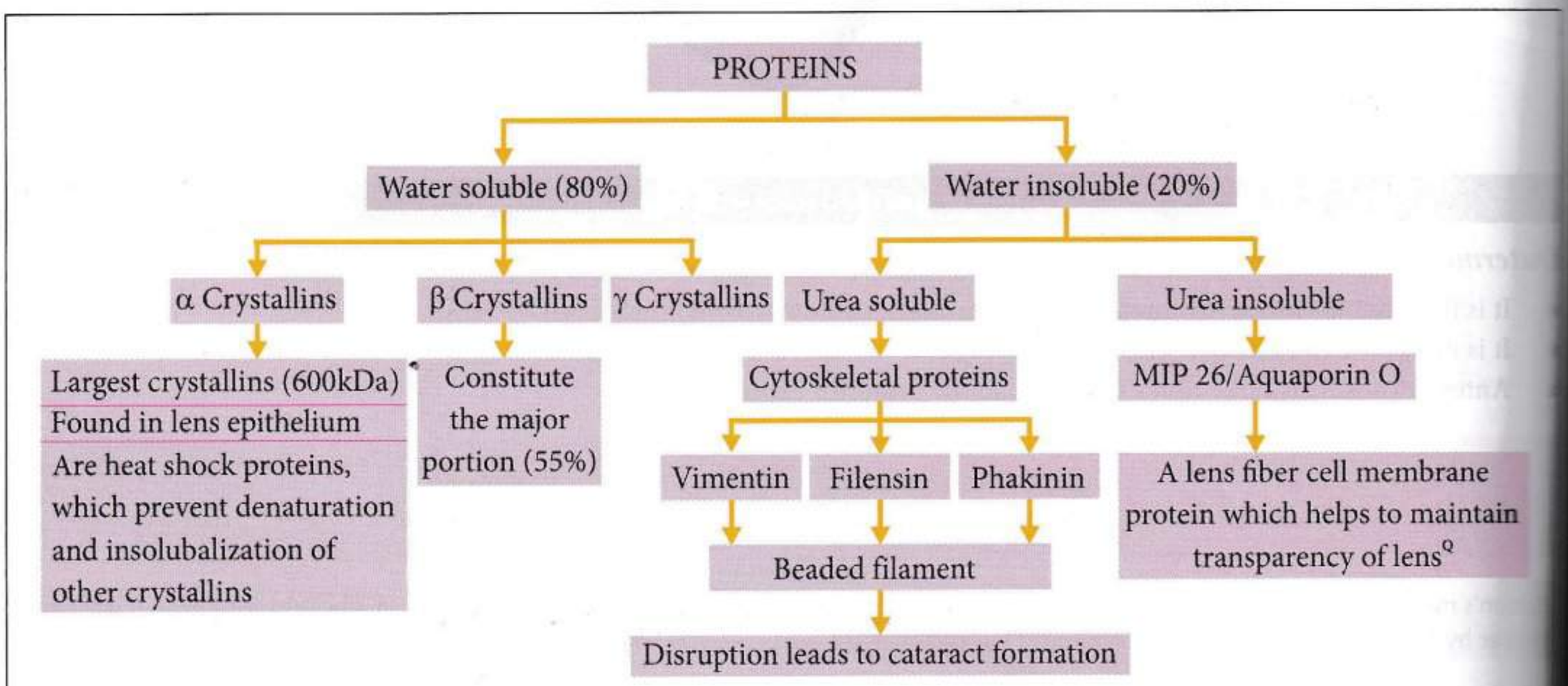
Anterior sutures
Y shaped[Q] - formed by interdigitations of apical cell processes

Posterior sutures
Λ (inverted Y) shaped - formed by interdigitations of basal cell processes

PHYSIOLOGY

Lens is composed of 64% water[Q], 35% proteins and 1% lipids, carbohydrates.

Proteins in Lens



EXTRA M

High molecular weight proteins (HMW) in lens

HM1 and HM2	–	Water soluble
HM3 and HM4[Q]	–	Water insoluble, found in higher concentrations in cataractous lens
HM4	–	Increased concentration in nuclear cataract

Changes in lens with Age

- Increase of water insoluble proteins[Q]
- Protein–protein and protein–glutathione disulfide bond formation
- Increased cross–linking of proteins by monosulfide bonds producing increased fluorescence
- Decreased levels of reduced glutathione (it is an antioxidant)
- HMW fractions grow into cell cytoplasm
- Decreasing refractive index of lens
- Increased anterior curvature

] This is the so called 'LENS PARADOX' – where an increase in power of lens (due to increased curvature) is offset by a decrease in power (due to decreasing refractive index of lens)

Antioxidant Mechanisms in Lens

- **Superoxide dismutase**[Q] breaks superoxide anion (O_2^-) to produce hydrogen peroxide
- **Catalase**[Q] – breaks peroxide to water
- Glutathione peroxidase and **glutathione reductase**[Q]—Major free radical scavenger in lens
- Vitamin C[Q]
- Vitamin E[Q]
- Low oxygen level around the lens – (Lost after vitrectomy, leading to increased incidence of nuclear cataract)

Carbohydrate Metabolism in Lens

Glucose is transported into the lens by both simple and facilitated diffusion[Q], mainly **from** aqueous[Q] and partly from vitreous[Q]. Thus, glucose transportation occurs at both, anterior and posterior surface of lens.

It is **metabolized by**

- > 80% – Anaerobic glycolysis[Q]
- 3% – Kreb's cycle (aerobic)
- 5% – HMP shunt
- 5% – Sorbitol pathway[Q]

Correlate Box

Sorbitol Pathway

When glucose levels increase in lens, due to rate limiting feedback inhibition of glycolysis, sorbitol pathway becomes more active.

Glucose —(Aldose reductase)→ Sorbitol —(Polyol dehydrogenase)→ Fructose

Both accumulate in lens

Increase the osmotic pressure of lens, drawing in fluid

Causes opacification of lens (CATARACT)

Sorbitol pathway is responsible for sugar cataract in Diabetes mellitus and Galactosemia

Electrochemical Balance

Lens is electronegative, with a potential of –70 mV across an intact lens capsule

↓

Lens has higher levels of K^+ and amino acids and lower levels of Na^+, Cl^- and water, than the surrounding aqueous and vitreous

↓

Thus, the flow of electrolytes into the lens is directed by an electrical gradient

Lens maintains its electrolyte and water balance via membrane transport processes mainly across the anterior lens capsule and anterior epithelium.

- Cation balance—Na^+ K^+ ATpase-dependent Na^+ extrusion and K^+ intake at the anterior epithelium which creates a concentration gradient for diffusion at the posterior surface—PUMP and LEAK theory.
- Sodium enters preferentially at poles.
- Potassium exits preferentially from equator.
- Ascorbic acid and myo-inositol—Active transport via Na^+ dependent **SVCT2**[Q]
- Amino acid—Active transport dependent on Na^+ gradient across lens

CATARACT

Any opacity in the (normally transparent) lens and/or its capsule is known as cataract.

Cataractogenesis

Risk factors for cataract	Pathomechanism of loss of transparency
• Increasing age • Sunlight (UV-A, UV-B) • Severe diarrheal dehydration • Vitamins A, C, E deficiency • Diabetes • Smoking • Corticosteroids • Genetic	• Oxidative damage to membranes and proteins • Hydration • Denaturation of proteins • Opacification of lens fibers with fibrous metaplasia • Opacification of lens epithelium • Accumulation of pigmented molecules (3-hydroxykynurenine and chromophores which lead to yellowing) • Disturbance in osmotic balance[Q] • Failure of ion pumps (increased intralenticular calcium and sodium with decrease in potassium)

All types of cataract present with **gradual, painless loss of vision** which is progressive in acquired cases and stationary in congenital cases.

ACQUIRED CATARACT

Senile Cataract/Age-Related Cataract

- Most common type of acquired cataract
- Usually affects persons above the age of 50 years.
- Occurs equally in men and women, usually bilateral and asymmetrical
- Pathogenesis is multifactorial with considerable genetic influence.
- Anticipation phenomenon is present – hereditary cases appear at an earlier age in successive generations

Types of Senile Cataract—Morphological

Nuclear Cataract

Involves the nucleus of lens, thus it is a type of **Central cataract**

↓

Causes more diminution of vision in daylight
(as pupil constricts in light, allowing light to pass through centre of lens only, where opacity is present)

↓

Thus, patient complains of **vision improving in dim illumination/at night**[Q]
Loss of vision is more for far than near

Pathology

Nuclear sclerosis[Q] (Exaggeration of the normal aging changes)

↓

Associated with dehydration and compaction of nucleus causing HARD cataract

↓

Leads to **increase in the refractive index** of the nucleus

↓

Causes **Index Myopia**—slowly progressive

↓

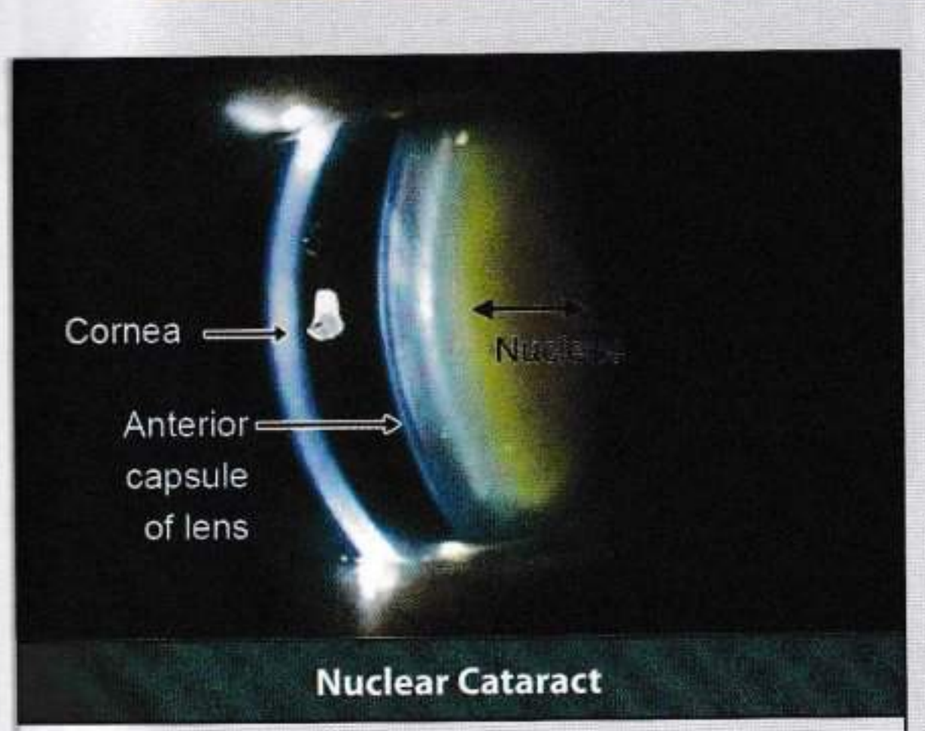
Myopic shift (Short Sightedness) in the patients enables the elderly Presbyopic individuals to read (near vision) clearly again without spectacles – **Second Sight**[Q] **phenomenon**

Appearance

Yellowish color/hue due to deposition of **Urochrome** pigment—derived from amino acid Tryptophan[Q]

↓

With progression, nuclear cataract becomes Brown—Cataracta Brunescens (Grade 3)
Black—Cataracta Nigra (Grade 4)



Nuclear Cataract

Best assessed on oblique illumination–slit lamp biomicroscopy

Cataracta Brunescens

Patient also complaints of

- **Xanthopsia**[Q]—Yellow colored vision
- **Monocular diplopia**—Due to abrupt change in refractive index between sclerotic nucleus and cortex.
- **Polyopia**—Due to multiple refractile areas in the centre of nucleus

Cortical Cataract

Involves the cortex of the lens, thus it is a type of **Peripheral cataract**

↓

Causes more diminution of vision in dim light[Q]

(as pupil dilates in dim illumination to allow more amount of light to enter through periphery, where opacities are now present)

↓

Thus, vision improves in bright light/day time

Pathology and Stages of Maturation

Hydration[Q] and coagulation of lens proteins

↓

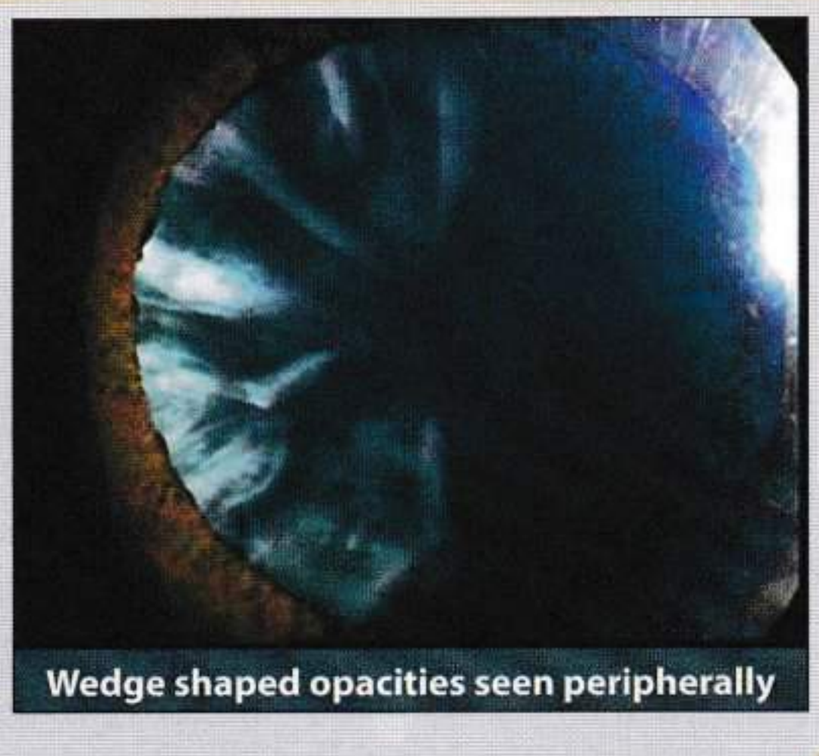
Formation of vacuoles and water cleft—**earliest Sign**[Q]

↓

Lamellar separation of cortical fibers

↓

Formation of wedge shaped (**Cuneiform**[Q]) opacities, with clear spaces in between—Incipient cataract
Most commonly in the inferonasal quadrant



Wedge shaped opacities seen peripherally

Retroillumination – spoke wheel like appearance

Immature senile cataract (ISC)

Gray colored opacity—with clear lens substance between pupillary margin and cataract—**iris shadow** is **present** on torch light examination

Mature senile cataract (MSC)

Pearly white[Q] colored—with complete opacification of the cortex such that the pupillary margin lies in contact with the cataract—**NO iris shadow seen**

Progressive hydration causes lens swelling—**Intumescent[Q] cataract**

Intumescent cataract—leads to shallow anterior chamber and causes 2° ACG— **phacomorphic glaucoma**

Hypermature senile cataract (HMSC) cortex becomes disintegrated

Morgagnian cataract

Liquefaction of the cortex[Q] leads to sinking of the nucleus

Liquefied milky cortex and brown mass (nucleus) seen with a semicircular line sinking to the bottom

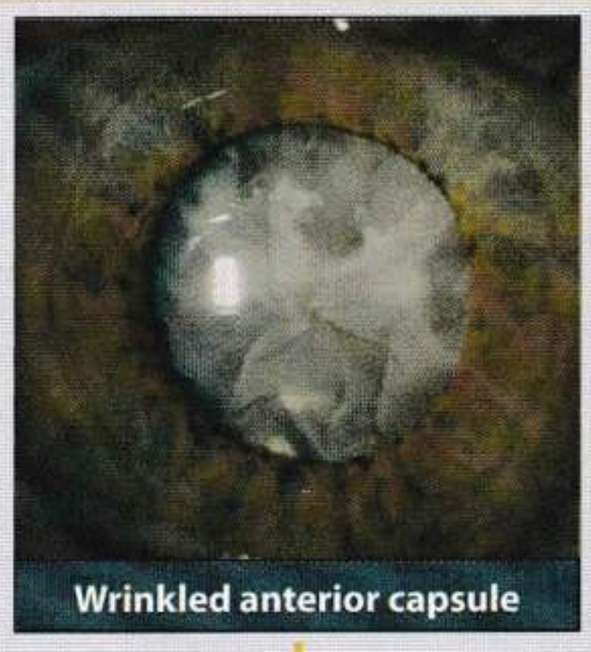
It has a propensity to cause phacolytic glaucoma[Q]

Sclerotic cataract

Degenerated cortical matter leaks through the lens capsule

Shrinking of lens - Antero-posterior diameter of lens decreases[Q]

Anterior capsule becomes thickened with calcification



Wrinkled anterior capsule

Owing to shrinkage, the lens and iris become tremulous (iridodonesis and phacodonesis)

May cause Subluxation of lens–**Most common** complication of HMSC[Q]

- Patient complaints of
  - Glare—due to light scattering
  - Monocular diplopia or polyopia
  - Colored halos around light

Posterior Subcapsular Cataract/Cupuliform Cataract

- Located in the posterior cortical layer, lying just in front of the posterior capsule, **axially**, having a vacuolated, granular or plaque-like appearance
- PSC **cause maximum visual disability**[Q], due to its location at/near the **Nodal point**[Q] of the eye
- Patient complaints of
  - **Loss of near vision**[Q] more than far vision
  - **Vision improves in dim illumination**[Q] and is poor under bright light conditions (owing to its central location – as in the case of nuclear cataract)
  - **Glare**[Q]

Posterior subcapsular cataract

Best assessed on Distant Direct Ophthalmoscopy

Pathology

Dysplasia of Germinative cells of epithelium near the equator

↓

Leading to posterior migration of cells from equator to the posterior axis

↓

During migration dysplastic cells undergo aberrant enlargement (**Bladder or Wedl cells**) and accumulate forming a plaque

Causes

- Myotonic dystrophy
- **Corticosteroid use**[Q]
- Ischemic diseases
- Ionizing radiations[Q] – X rays
- Traumatic cataract
- Neurofibromatosis–2
- Inflammation (uveitis)
- Chloroquine
- Busulfan

Metabolic Cataract

Diabetes Mellitus

- Occurs due to hyperglycemia related activation of sorbitol pathway (as described earlier)
- It may lead to
  - **PreSenile cataract**—age-related/senile cataract developing earlier in diabetic patients due to accumulation of sorbitol within lens, increased glycolytic **carbamylation of crystallins**[Q] and greater oxidative stress

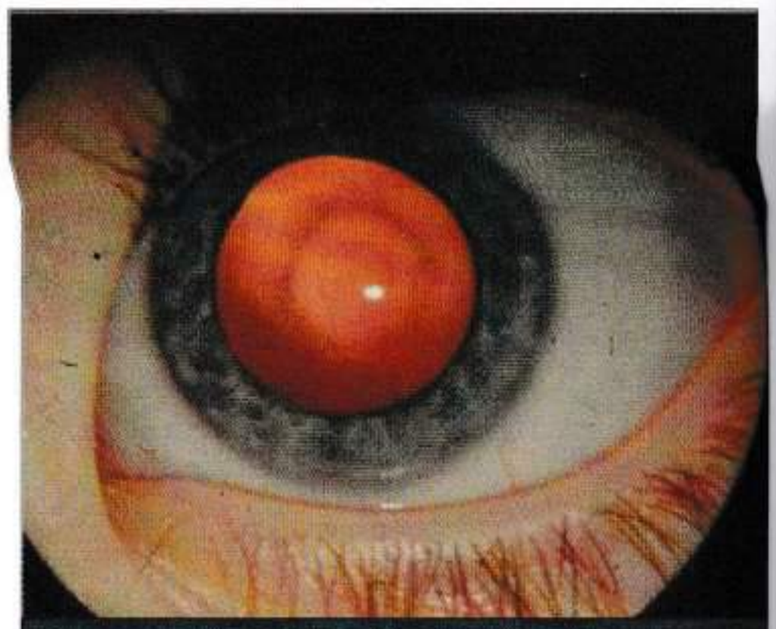
    PreSenile cataract is seen in Type 2 DM, myotonic dystrophy and atopic dermatitis

  - True diabetic cataract/**Snowflake**[Q] cataract—bilateral, acute, cortical (**anterior and posterior cortex**) opacities seen in young patients with uncontrolled diabetes mellitus.
    More common in patients with type 1 DM
- In milder cases, fluctuation of refractive error[Q] occurs in relation with plasma glucose levels

Snow flake cataract

Galactosemia

- Associated with development of **Oil–droplet** cataract–bilateral, **posterior subcapsular** opacities which later becomes nuclear.
- Exclusion of galactose **may reverse**[Q] the lenticular changes



Oil droplet cataract

Correlate Box

It is an autosomal recessive (AR) inherited inability to convert galactose to glucose

↓

Galactose and its metabolite galactitol[Q] (dulcitol) accumulate in lens, resulting in osmotic swelling and hence, cataract

↓

It may be due to deficiency of

Gal-1-PUT (Classical)	UDP galactose 4 epimerase	Galactokinase
Present with failure to thrive, diarrhea, vomiting, mental retardation, hepatomegaly and cataract within first few weeks of life		Presents only with cataract

Diagnosed by urine assay–shows presence of reducing substances[Q]

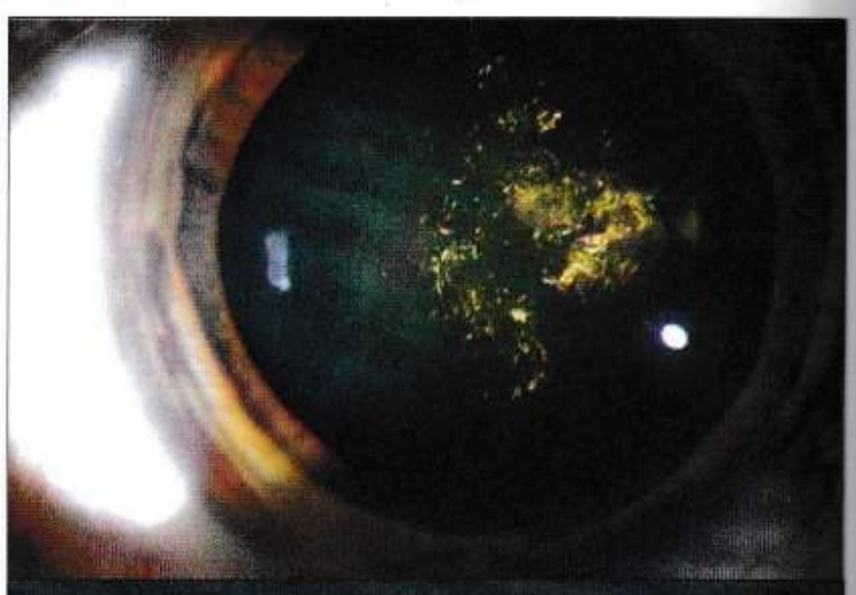
Myotonic Dystrophy

- 90% patients develop fine, dust like opacities with interspersed polychromatic stellate iridescent crystals in the lens cortex

↓

Appears like a **Christmas Tree cataract**[Q] progresses to posterior subcapsular cataract[Q]

AD condition characterized by delayed relaxation of muscles, ptosis, myotonia



Christmas Tree Cataract

Wilson's Disease

- Characteristic **Sunflower**[Q] **cataract** due to deposition of cuprous oxide in anterior capsule and subcapsular area in a stellate shaped pattern

↓

Not visually debilitating[Q]

- Also presents with **Kayser–Fleischer ring**[Q]—a golden brown deposition of copper in descemet's membrane[Q] at the periphery of cornea.

Sunflower cataract

Parathyroid Tetany

Cataract occurs due to associated **Hypocalcemia**[Q]

- Lamellar cataract in children
- Anterior and posterior subcapsular cataract, separated from capsule by a clear zone – in adults

Mnemonic

Sun Will	→	Sunflower cataract – Willon's disease
Glow **On**	→	Galactosemia – oil droplet cataract
Christmas		
Melting	→	Christmas tree cataract – Myotonic dystrophy
Snow in **D**elhi	→	Snowflake cataract – Diabetes Mellitus

Complicated Cataract

Cause

Due to disturbance of lens nutrition secondary to

- Chronic anterior **U**veitis[Q] – most common cause
- High **M**yopia
- **A**ngle closure glaucoma
- Fundus dystrophies like **R**etinitis pigmentosa[Q]

Mnemonic

Remember as
UMAR
or
RAMU

Pathology

Cataract occurs as posterior cortical atrophy in the axial region near the nodal point

↓

Present as posterior cortical[Q]/Posterior subcapsular[Q] cataract

↓

Having **Breadcrumb appearance**[Q] **with Polychromatic lustre**[Q]

Other Causes of Acquired Cataract

Blunt Trauma	Rosette shaped cataract
Ionizing radiation	Posterior subcapsular cataract
Infrared radiation	Glassblowers cataract – True exfoliation of lens capsule
Electric shock/ lightning	Anterior subcapsular, peripheral iridescent opacities
Acute Angle closure glaucoma **(AACG)** (Remember as AACG–causes of Anterior subcapsular cataract)	Shield cataract–Anterior subcapsular opacities
Atopic Dermatitis	Glaukomflecken
Amiodarone and Anticholinesterases	Anterior subcapsular cataract
Chlorpromazine (Phenothiazines)	Golden anterior subcapsular deposits
Gold	Yellow brown anterior capsular opacities
Alkali chemical injuries	Cortical cataract
Siderosis bulbi (Iron)	Cortical cataract

Management of Adult Onset Cataract

- Cataract is the most common cause of blindness in India, but the blindness is preventable by timely treatment
- There is no medical therapy for cataract treatment
- **Surgical treatment is the mainstay**

Indications for Cataract Surgery

- Optical indications
  - Bilateral visually significant cataracts
    - Eye with the more advanced cataract operated first
    - Eye with the better visual acuity operated first, if associated with any other ocular pathology causing visual loss
  - Monocular cataract
    - Loss of stereopsis
    - Symptomatic anisometropia
    - Disabling glare

The patient's desire for improved vision is the most common indication[Q]

- Medical indications: Phacolytic glaucoma, phacomorphic glaucoma, phacoantigenic uveitis and dislocation/subluxation of lens into anterior chamber[Q]

Preoperative Evaluation

Evaluate symptoms caused by Opacity

- Visual acuity[Q] – by Snellen's chart followed by refraction to measure. Best corrected visual acuity (BCVA)
- **Contrast sensitivity**[Q] by Pelli Robson chart — **maybe diminished even with normal visual acuity**
- Glare and monocular diplopia

↓

Slit Lamp and Fundus Examination

- Pupil : Examine to exclude RAPD, etc. indicating neuropathy, if pseudoexfoliation is present (diagnosed by loss of pupillary frill) – indicates chances of zonular dialysis and poor mydriasis
- Cornea—evaluate for any previous refractive errors and abnormalities of endothelial layer
- IOP measurement by Tonometry[Q]
- Retinal/macular function tests : Check perception of light in both eyes, color perception[Q] - indicates optic nerve function, Two-point discrimination test, specific tests (ERG, EOG, OCT, etc) if retinal pathology present

Blue light entoptoscopy and Purkinje's entoptic phenomenon are tests for macular function—based on visualization of shadow images

↓

Grading of lens opacities is done by LOCS III system

Developed by Chyleak et al – based on comparing opacities with a set standard of photographs for color and opalescence

↓

Preparation for surgery
Preoperative pharmacotherapy

↓

Dilate pupil-mydriatic cycloplegics ↓ Tropicamide/cyclopentolate + Phenylephrine (contraindicated in hypertensives)	Antibiotics ↓ Povidone iodine (5%) Topical antibiotics	NSAIDs Prevent intraoperative miosis and postoperative CME	Anesthesia Peribulbar block is safer ↓ Bupivacaine + liganocaine + 1:200000 Adrenaline + Hyaluronidase

- **Universal prophylaxis**–5% Povidone iodine in the conjunctival sac for at least 60 seconds prior to start of surgery
- **Malyugin ring** used to dilate pupil in complicated cases, with small non-dilating pupil, e.g. diabetes

Surgical Techniques

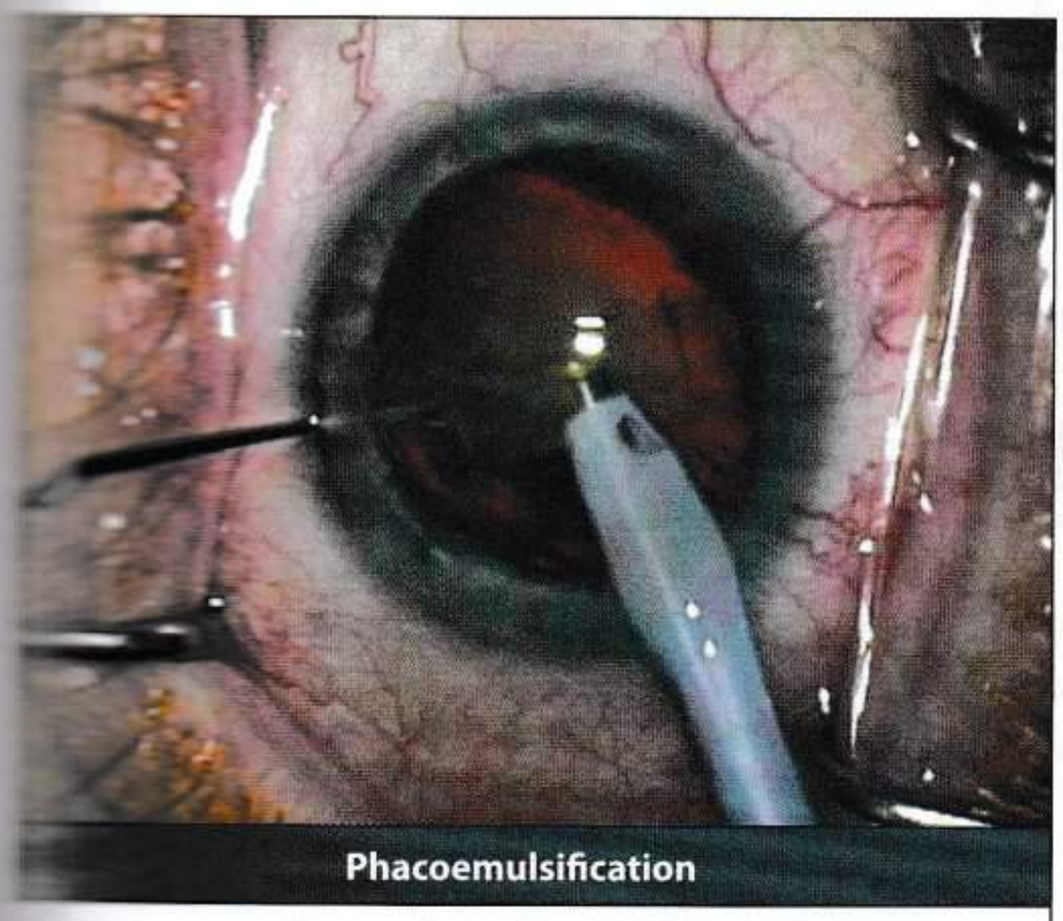
Intracapsular Cataract Extraction (ICCE)

- Lens is removed completely along with the capsule
- Implantation of anterior chamber intraocular lens (ACIOL) is done
- **Only indication**–subluxation of lens due to >180° zonular dehiscence (breakage of ciliary zonules)

Extracapsular Cataract Extraction (ECCE)

- Lens fibers (nucleus and cortex) are removed along with anterior capsulotomy, followed by implantation of IOL
- ECCE techniques:

	Site of Incision	Size of Incision
Conventional ECCE	Limbus	8–10 mm
Small incision cataract surgery (SICS)	Sclera (sclera-corneal tunnel)	5–7 mm
Phacoemulsification	Clear corneal	2.2–3.2 mm



Phacoemulsification

Phaco probe with rubber sleeve

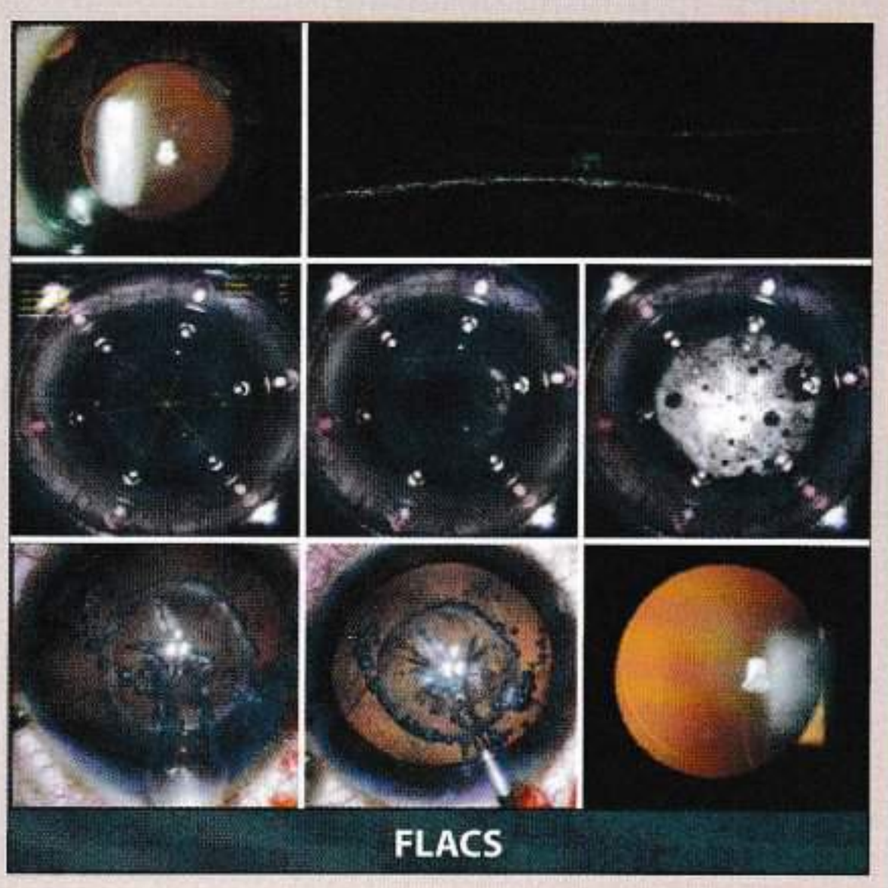
SICS

Sclerocorneal tunnel construction

Recent Advances

Latest surgery for cataract is FLACS – Femtosecond-assisted Laser cataract surgery

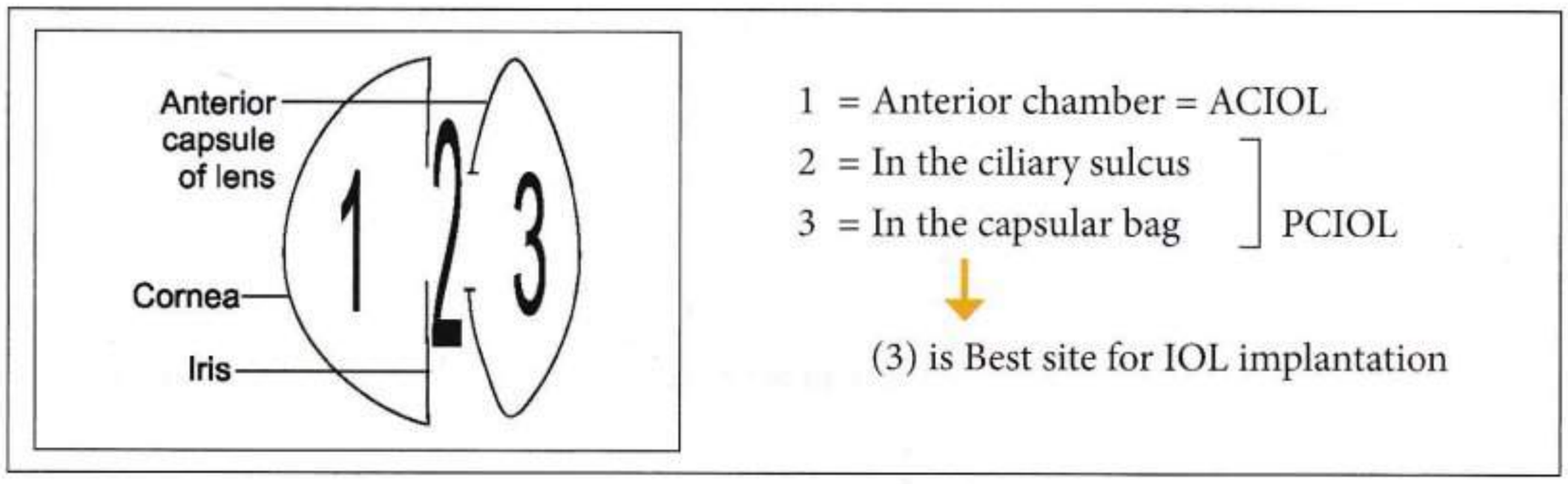
- **Neodymium: Glass laser** – 1053 nm wavelength used
- Light focused at 3 µm spot size
- Laser beam fired in pulses of 10^{-15} seconds^{Q} eliminating collateral damage to surrounding tissues
- Femtosecond laser works via **photo-disruption**, used to create corneal incisions, anterior capsulotomy and for lens fragmentation



FLACS

Intraocular Lens (IOL)

After ECCE based surgeries, IOL may be implanted in



Kelman ACIOL
S-shaped haptic

PCIOL
C-shaped haptic

PCIOL
Plate design

Extra Mile

- Best IOL design is biconvex
- IOL can either be
  - **Rigid**—made up of PMMA (Polymethyl methacrylate)
  - **Foldable**—made up of
    - Silicone – Contraindicated in patients who are likely to require vitreoretinal surgery in the future (diabetes, high myopia, retinal detachment)
    - Acrylic – 3 piece or 1 piece, usually hydrophobic
    - Collamer – composed of polyHEMA (hydroxy ethyl methacrylate) copolymer
- **Special IOL designs**
  - Square edge optics – reduce rate of posterior capsular opacification
  - Multifocal IOL: Consists of a series of zones (appearing as concentric circles) to provide focus at near, distance and intermediate distance
    As a drawback, patients suffer from poor contrast sensitivity
  - Aspheric surface IOL: Counteract spherical aberration
  - Heparin coated IOL: Preferable in uveitic eyes
  - Toric IOL: Spherocylindrical lens to correct pre-existing corneal astigmatism
  - Blue blocking IOL: Attenuate blue wavelength light, protecting macula from exposure to blue light, but these lenses might create problem with scotopic vision

Multifocal IOL

Fine concentric circles/zones visible in the optical area

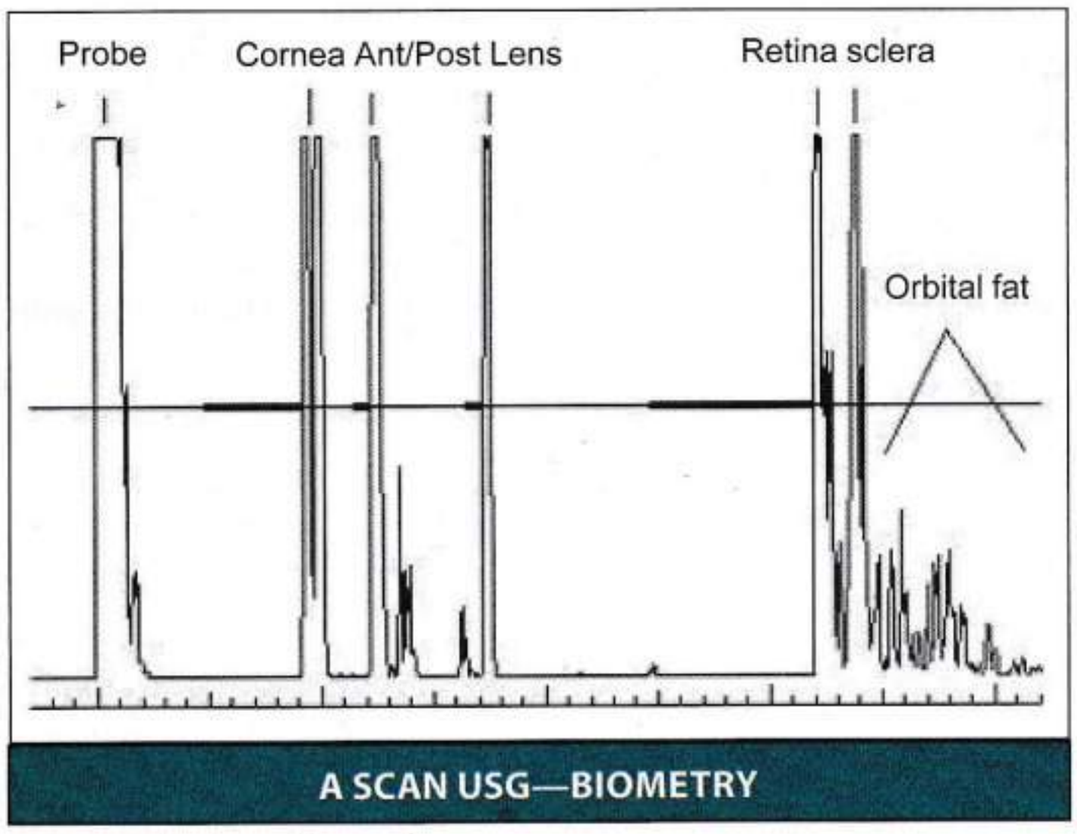
Determination of IOL Power

As the refractive status (normal curvature, axial length, total power of eye, etc.) is different for each eye in an individual, thus determination of IOL power to be implanted assumes significance.

Step 1: Measure corneal curvature to determine power of cornea—**Keratometry** (Discussed in Cornea)

Step 2: Measure Axial length of eyeball—**A scan ultrasonography** or **Biometry**

- Amplitude (A) scan: **8 MHz** frequency of sound waves. Echoes that return to the transducer are converted into a series of spikes with height proportional to the strength of echo. The **linear distance between spikes allows calculations of distance between interfaces.**



A SCAN USG—BIOMETRY

- Performed with a contact application transducer or an immersion technique (better)

IOL master is a device that can perform both Step 1 and Step 2 – using optical coherence biometry as a principle. It is a noncontact technique but measurements are confounded by patient non-compliance, corneal scarring, mature posterior subcapasular cataract or vitreous hemorrhage

Step 3: **IOL power calculation**

- Sanders, Retzalf, Kraff (**SRK–II**) formulae–most commonly used

$$P = A - (2.5\ L) - 0.9\ K$$

P = Power of IOL implant (diopters), A = constant specific for IOL, L = axial length (mm),
K = Keratometry values (diopters)

- **SRK–T** formulae–useful if axial length > 26 mm.
- **Hoffer Q** formulae–useful if axial length < 22 mm.

Surgical aim is to overcorrect, with a –0.25D to –0.50D Myopia

Postoperative Pharmacotherapy and Care

	Conventional extracapsular cataract extraction	Phacoemulsification
Topical steroid-antibiotic eye drops	6–8 weeks	3–4 weeks
Topical mydriatic-cycloplegic	1–2 weeks	1–2 weeks
Topical medication to reduce the intraocular pressure	1–2 weeks	1–2 weeks
Refraction and prescription of glasses	6–8 weeks	1–2 weeks
General precautions, restriction of physical activity	6–8 weeks	1–2 weeks

EXTRA MILE

In SICS – a Bridle (superior rectus) suture is passed to fix the eye in a downward gaze giving access to the superior sclera to enable the formation of a Sclerocorneal tunnel.

It also aids in providing a counteraction force during delivery of nucleus outside the eyeball.

EXTRA MILE

Phacoemulsification

It uses an ultrasonically driven tip with a piezoelectric crystal as transducer which converts electrical energy to mechanical energy[Q]– used to breakdown the nuclear material into pieces
Phaco handpiece has a to and fro, jackhammer action along with vacuum and fluid dynamics. Phaco tips are beveled at (usually) 45°

Steps

Topical or Local (Peribulbar/Retrobulbar) Anesthesia

↓

Paracentesis – 15° sharp blade used to create a small incision
3 clock hours away from main incision

↓

Clear corneal incision–Temporal site better than superior approach

↓

CCC–Continuous curvilinear capsulorhexis[Q] better than can–opener capsulotomy as it resists radial tears, helps stabilize the nucleus and center the lens implant.
Staining with TRYPAN BLUE[Q] dye may be done for better visualization of anterior capsule

↓

Hydrodissection
Separation of cortex from underlying posterior lens capsule

↓

Hydrodelineation
Separation of endonucleus from epinucleus

↓

Emulsification of nucleus usually done in the posterior chamber

↓

Aspiration and irrigation to remove residual cortical matter

↓

Implantation of foldable IOL into the capsular bag

15° side port

Corneal incision – 3 mm diamond beveled blade

CCC and stained anterior capsule

IOL implantation unfolding in the capsular bag

EXTRA MILE

Viscoelastics/Ocular Viscosurgical Device (OVD)

Biopolymers containing glycosaminoglycans (GAG's) and Hydroxy–propylmethylcellulose (HPMC), used for maintenance of anterior chamber depth during surgery and for forming a protective layer on corneal endothelium to protect it from damage by instrumentation

2 types

Cohesive(s)	Dispersive(s)
• High molecular weight • Low viscosity • Used to maintain AC • Easily removed • Sodium hyaluronate 1%, 1.6% • E.g. Healon, Healon GV	• Low molecular weight • High viscosity • Used to coat and protect endothelium • Difficult to remove • Sodium hyaluronate + chondroitin sulfate (3–4%) • Viscoat

Complications of Cataract Surgery

Operative	Acute Postoperative (within 3 weeks)	Late postoperative (after 1 month to years)
• Posterior capsular rupture (PCR) • Uveitis–glaucoma–Hyphema[Q] **syndrome (UGH)** – due to iris chaffing by ACIOL[Q] • Vitreous loss – most serious • **Expulsive choroidal hemorrhage**– bleeding from choroidal artery • Damage to superior rectus while passing bridle suture • **Descemet membrane detachment** – reattached by injecting air bubble or gas in AC – Descemetopexy	• Iris prolapse • Acute postoperative **endophthalmitis** (within 7 days after surgery) • Uveitis • Retained lens matter • Hyphema • Astigmatism • Retinal detachment • Toxic anterior segment syndrome **(TASS)** • **Flat/shallow AC**[Q] ▪ Wound leak ▪ Ciliary choroidal detachment ▪ Pupillary block glaucoma ▪ Malignant glaucoma • **Brown–Mclean syndrome** – after ICCE – peripheral corneal edema	• Posterior capsular opacification **(PCO)** – most common • Retinal detachment • **Irvin Gass syndrome**[Q] – after 6 to 10 weeks – cystoid macular edema + Bullous keratopathy + Vitreous touch • **Displacement of IOL** ▪ Sunset syndrome – inferior subluxation ▪ Sunrise syndrome – superior subluxation ▪ Lost lens syndrome – complete dislocation • **Anterior capsular phimosis** – contraction of anterior capsule due to fibrosis causing IOL decentration • Late onset **endophthalmitis**

TASS vs endophthalmitis

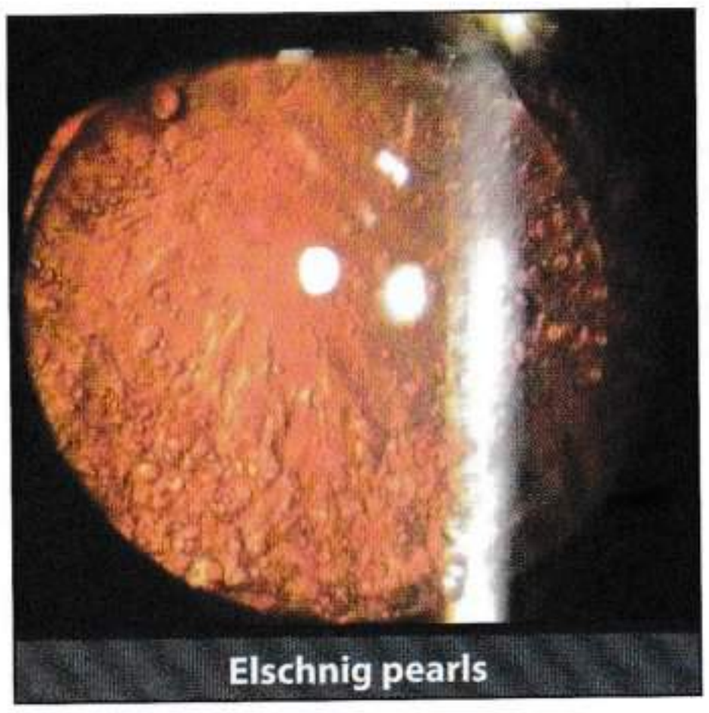
TASS	Endophthalmitis
Onset usually within 24 hours	Within 4 to 7 days
Usually limited to the anterior segment	Severe vitritis with loss of red reflex is universal finding
Mild pain	Severe pain
Complete limbus to limbus corneal edema is seen	Rare
Lid chemosis seen	Severe lid swelling, chemosis
Always gram stain and culture negative	Infective
Treatment is topical corticosteroids	Intravitreal antibiotics are the key, oral steroids may be used in severe cases (rule out fungal causes)
Hypopyon + fibrin formation	Hypopyon + fibrin formation
Sterile inflammatory reaction caused by a non-infectious substance, resulting in toxic damage to intraocular tissues	Inflammation of all structures of eyeball except Sclera[Q] due to bacteria or fungi

Posterior Capsular Opacification (after Cataract or Secondary Cataract)

- The **most common** complication of cataract surgery (ECCE techniques like phacoemulsification), usually occurring **9–12 months** after surgery.
- It presents with reduced visual acuity, impaired contrast sensitivity and monocular diplopia.

> PCO is not a type of cataract – it gets the name of being a cataract as it presents like a cataract

- It is of **2 types**
  - **Elschnig pearls** – formed by proliferation and migration of residual subcapsular equatorial epithelial cells along the posterior capsule, imparting a vacuolated appearance on retroillumination (Most common type of PCO)
  - **Ring of Sömmering** – capsular fibrosis due to fibrous metaplasia of epithelial cells.
- Treatment: **Nd:YAG laser capsulotomy** or removal by help of ziegler knife.



Elschnig pearls

Ring of Sömmerring

CONGENITAL CATARACT

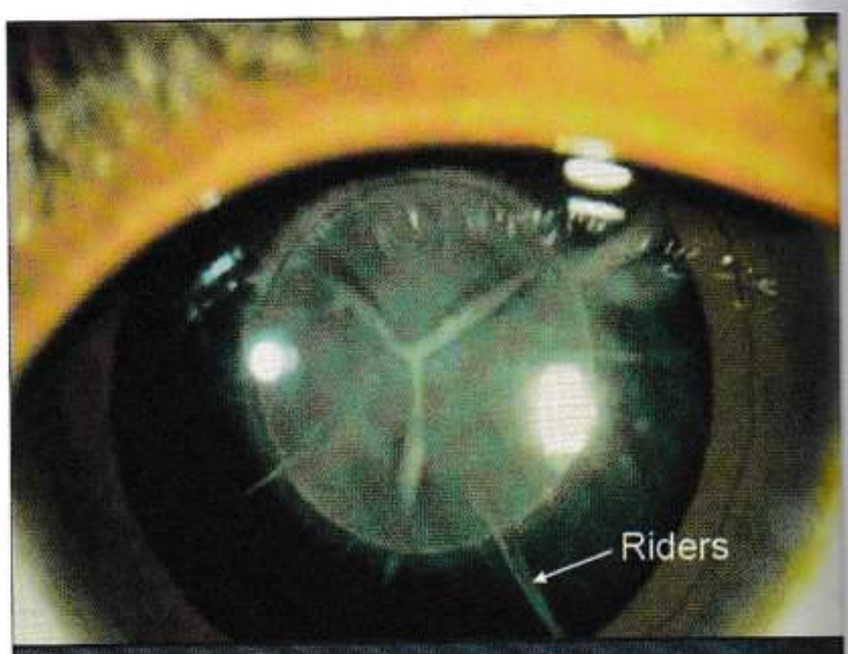
The term refers to a lens opacity present at birth, developing either during the first year of life (infantile cataract) or later (developmental cataract)

Infantile	Developmental
Lens opacities develop **within the first year of life**	Lens opacities develop **after 1 year of age**
Leads to **severe loss of vision**, due to interference with development of foveal fixation (which usually develops between 3 and 4 months of age)	**Minimal visual loss**, proportionate to the lens opacity visible

Types of Congenital Cataract

Zonular/Lamellar cataract

- **Most common** visually significant congenital cataract
- **Caused by**
  - Inherited Autosomal Dominant (AD)
  - Vitamin D deficiency
  - Congenital rubella syndrome
- **Presents with** an opacity in the **Fetal nucleus** – with the area around and within usually clear. Seen associated are linear/arcuate opacities at equator of the cataract known as **Riders**[Q], giving spokes of a wheel appearance
- Usually Bilateral



Lamellar cataract

Disc shaped cataract with Riders and Sutural cataract (Y shaped)

EXTRA MILE

Congenital Rubella Syndrome

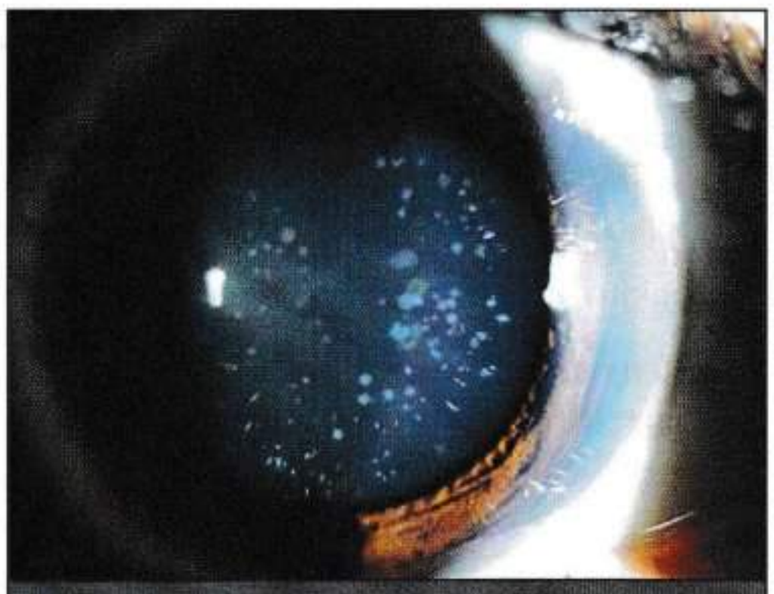
- Most commonly affects fetus in the 1st trimester[Q] of pregnancy
- Ocular clinical features
  - Unilateral or bilateral embryonal **Nuclear pearly cataract** (most common) in ~ 15% cases
  - Live virus particles persist within lens till 3 years of age
  - Microphthalmos – when axial length at 1 year of age is < 19 mm or axial length in adult < 21 mm.
  - Glaucoma
  - Pigmentary **(Salt and Pepper)[Q] retinopathy**
  - Corneal clouding–due to keratitis

Punctate Cataract (DOT like Opacities)

- **Most common congenital/developmental cataract**[Q] – not visually significant[Q] and does not require surgery
- Blue dot cataract/Cerulean-universal in occurrence

> Down Syndrome[Q] – Blue dot cataract, Iris hypoplasia, Keratoconus, Brushfield spots

- Sutural cataract – affecting the Y shaped sutures in fetal nucleus
- Cataracta centralis pulverulenta – powdery, fine white dots within the embryonic or fetal nucleus



Blue Dot Cataract

Anterior Polar Cataract

- Occurs usually due to flat anterior chamber after perforation of a corneal ulcer[Q] with contact of anterior lens surface and cornea

↓

White plaque forms at the anterior pole of lens sometimes projects in the anterior chamber
Pyramidal cataract

↓

May be associated with underlying anterior cortical cataract – **Imprint** cataract
(Usually the anterior polar cataract and its imprint are separated by clear lens fibers, giving appearance of mirror images together known as **Reduplicated Cataract**)

- May also be associated with anterior lenticonus, aniridia, peters anomaly.

Posterior Polar Cataract

- PPC has a **Whorled/Onion Ring**[Q] appearance
- Associated with
  - Persistent hyperplastic primary vitreous (PHPV)
  - **Mittendorf dots**[Q] – remnants of Tunica vasculosa lentis
  - Mutation of PITX 3 gene

Posterior Polar Cataract

ONION RING appearance

Coronary Cataract

- Club shaped opacities near the periphery of lens
- Usually affects cortex and adult nucleus

Treatment

Treatment depends on density and laterality of cataract

Bilateral, dense	Bilateral, partial	Unilateral, dense	Unilateral, partial
Surgery by 12 weeks[Q] of age to prevent amblyopia	Defer surgery	Surgery done immediately[Q], with in 4–6 weeks of age followed by Antiamblyopia therapy	Occlusion therapy etc. (Anti-ambylopia)

Surgery

Indications for surgery in pediatric age group

- Dense cataract > 3 mm in diameter, covering the visual axis
- Pupil does not dilate
- Squint/nystagmus is seen to develop – indicates amblyopia

- **Lens aspiration[Q] with anterior vitrectomy[Q] with posterior capsulorhexis[Q]** (to reduce occurrence of posterior capsular opacification) and IOL implantation (>2 years of age)[Q]
- Extra-capsular cataract extraction[Q] techniques are the choice

Guidelines for the Choice of Intraocular Lens Dioptric Power

Children less than 2 years old

- Do biometry and undercorrect by 20%, or
- Use axial length measurements only:

Axial length IOL dioptic power

17 mm, 25D
18 mm, 24D
19 mm, 23D
20 mm, 21D
21 mm, 19D

Children between 2 and 8 years old

- Do biometry and undercorrect by 10%

EXTRA MILE

Various Systemic conditions can be associated with congenital cataract

- Galactosemia
- Lowe syndrome
- Fabry disease
- Mannosidosis
- Hypoglycemia[Q]
- Toxoplasmosis
- Cytomegalovirus
- Varicella
- Down syndrome
- Edwards syndrome
- Cri-du-chat syndrome
- Zellweger syndrome

ECTOPIA LENTIS

Ectopia lentis (EL) refers to displacement of lens from its normal position

Subluxation of lens
Partially displaced – some part still visible in the pupillary area

→ Assess and give best correction for refraction through aphakic area

Dislocated lens
Completely displaced from pupillary area– appears aphakic

- **Anteriorly** (with Inverse glaucoma) Lens removal with IOP control
- **Posteriorly** (with uveitis) lens removal

Causes

Acquired

- **Trauma**—most common cause[Q]
- Anterior uveal tumors – melanomas
- Hypermature senile cataract
- Large eyeball
- Pseudoexfoliation syndrome
- Inflammation (as in cyclitis or syphilis)

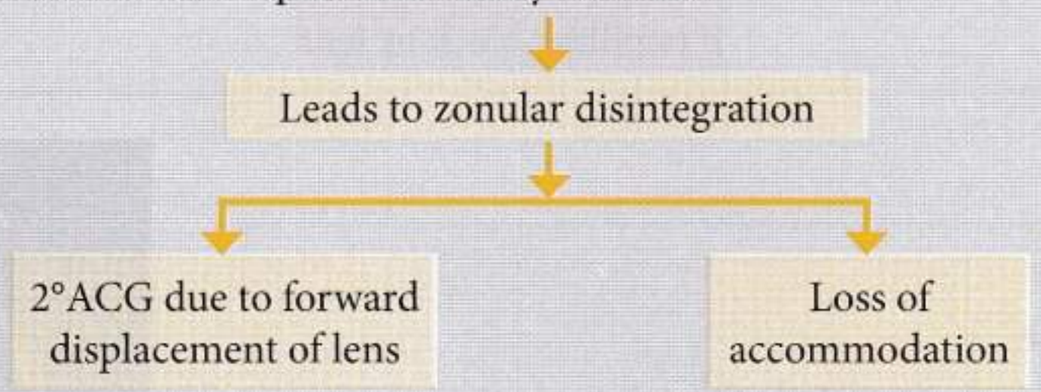
Hereditary

Without Systemic Abnormalities

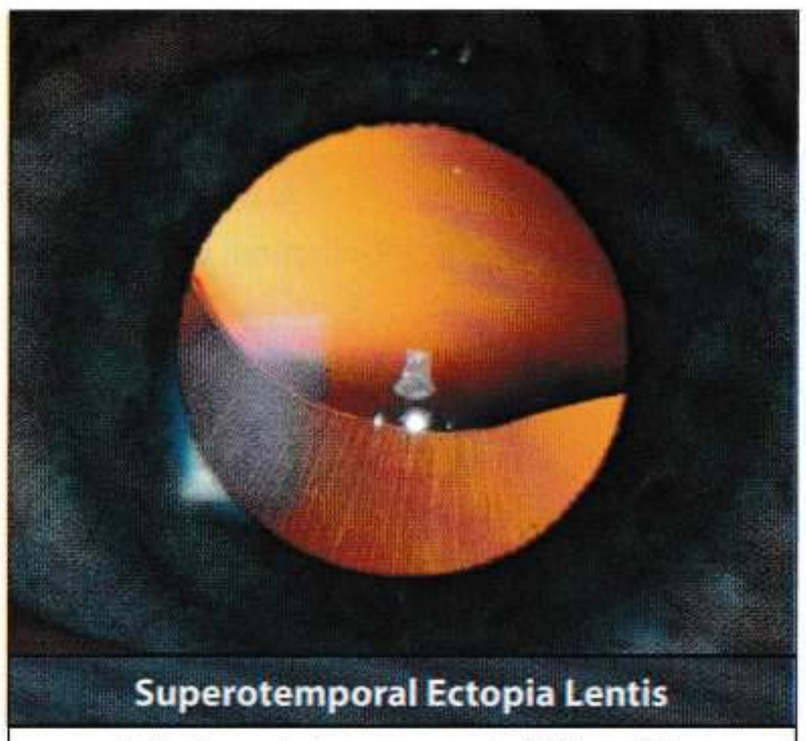
- Familial—Bilateral EL, inherited AD
- Ectopia lentis et pupillae—Congenital, bilateral and asymmetric EL where pupil and lens move in opposite directions
- Aniridia

With Systemic Abnormalities

- **Marfan syndrome**—AD inherited
  - Bilateral Superotemporal EL—most common ocular sign
  - Cornea Plana & Megalocornea
  - Dilator pupillae (Iris) hypoplasia
  - Axial myopia
  - Lattice degeneration with rhegmatogenous retinal detachment
- **Homocystinuria**—AR inherited
  - Bilateral Inferonasal EL
  - Deficiency of cysteine (deficiency of cystathionine beta synthase leading to accumulation of homocysteine and methionine) disturbs the normal development of ciliary zonules



  - Diagnosis-Homocysteine in urine is detected by **cyanide nitroprusside** test
- **Weill-Marchesani syndrome**—AR inherited
  - Anterior and inferior EL associated with microspherophakia
  - Patient characteristically has a short stature with small, stubby fingers
- Hyperlysinemia
- Sulfite oxidase deficiency (EL is universal)
- Ehler–Danlos syndrome
- Stickler syndrome (retinal detachment is most common ocular manifestation)



Superotemporal Ectopia Lentis

Inferior golden crescent visible with ciliary zonules-removal of lens needed

Clinical Features

- In subluxation of lens—edge of the displaced lens appears as a **Golden or dark crescent** in the pupillary area
- Mono-ocular diplopia and glare
- Astigmatism and myopia
- Iridodonesis and Phacodonesis

SHAPE ABNORMALITIES OF LENS

Microspherophakia

Small (micro) and spherical (sphero) lens, which causes

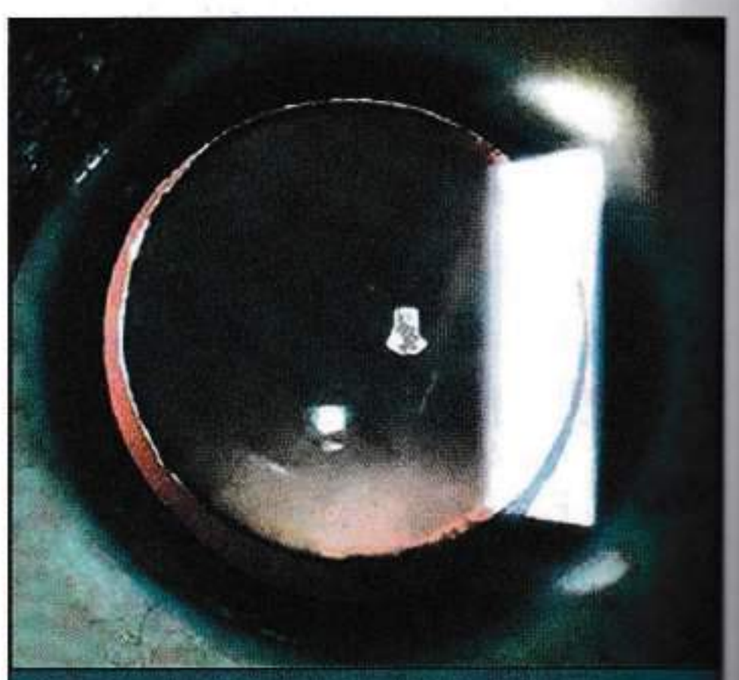
- Myopia due to increased lenticular curvature
- Luxation of lens in anterior chamber
  - 2°ACG if pupillary block by lens
- Lens equator is visible in a dilated pupil

Causes

- Familial–AD
- Weill—Marchesani syndrome
- Marfan syndrome
- Hyperlysinemia

] associated with ectopia lentis

- Alport syndrome
- Peters anomaly
- Congenital rubella syndrome



Microspherophakia

Lens equator visible

Lenticonus

Cone shaped bulging of the lens surface is lenticonus

Anterior Lenticonus	Posterior Lenticonus
Usually bilateral anterior axial bulging of lens visible as an oil droplet reflex on retinoscopy	Unilateral, usually sporadic posterior bulge of lens
Cause(s)	**Cause**
Alport syndrome • AD/XLR • Sensorineural deafness + abnormal glomerular basement membrane • Anterior lenticonus + fleck retinopathy + posterior polymorphous corneal dystrophy (PPCD)	**LOWE syndrome** • XL inheritance • Congenital cataract—universal finding—screening for amino acids in urine is done • Congenital glaucoma • Microphakia • Posterior lenticonus • Miosis
Waardenburg syndrome • Poliosis – greying of eyelashes • Anterior lenticonus + Heterochromia iridis + Telecanthus	

Anterior Lenticonus

Remember as SAW

Anterior lenticonus

Posterior Lenticonus

Posterior lenticonus

LAST MINUTE REVISION – ONE LINERS

- Centre of lens (Nucleus) has the maximum refractive index in eye – 1.406.
- Lens has no blood supply, nerve supply and is transparent.
- Lens capsule is thinnest at posterior pole (4 μm) and thickest at posterior pre-equatorial part (23 μm).
- Lens sutures are located in the fetal nucleus.
- Lens is composed by 64% water and 35% proteins.
- Water soluble proteins (crystallins and HM 1 and 2) are more in a normal lens in young age.
- Water insoluble proteins increase with age and in cataract (HM3 and HM4)
- Anaerobic glycolysis is the major pathway for carbohydrate metabolism.
- Cataract occurs in Diabetes and Galactosemia via metabolism of glucose through sorbitol pathway (NADPH dependent aldose reductase)
- Lens is electronegative – 70 mV.
- Na^+ dependent active transport occurs for cations, amino acids, ascorbic acid and myo–inositol
- Nuclear cataract: Sclerosis, second sight, Index Myopia, yellow color due to urochrome
- Cortical cataract: Hydration, cuneiform cataract, incipient cataract, intumescent cataract
- Phacolytic (2°OAG) glaucoma is caused by morgagnian cataract.
- Most common complication of sclerotic hypermature cataract is subluxation of lens.
- Vision improves in dim illumination if central opacity like in nuclear and posterior subcapsular cataract.
- Maximum visual loss and maximum loss of contrast sensitivity is caused by PSC.
- Bladder/well cells — PSC or Elschnig pearls
  Onion ring/whorled appearance — Posterior polar cataract
  Snowflake cataract — Type 1 Diabetes mellitus
  Oil droplet cataract — Galactosemia
  Christmas Tree cataract — Myotonic dystrophy
  Sunflower cataract — Wilson disease/Chalcosis
  Rosette shaped cataract — Blunt trauma
  Breadcrumb appearance with polychromatic luster — Complicated cataract
- Posterior subcapsular cataract: Steroids, Ionizing radiation, Diabetes mellitus, Blunt Trauma, Myotonic dystrophy, Neurofibromatosis—2, Chloroquine, Busulfan
- Anterior Subcapsular cataract: Atopic dermatitis, Angle closure glaucoma, Amiodarone, Chlorpromazine, Anti-cholinestrases, Gold depositis.
- Congenital rubella syndrome and Hypoglycemia cause embryonic nuclear cataract and Lamellar cataract.
- Punctate cataract is the most common congenital cataract.
- Lamellar/zonular cataract is the most common visually handicapping congenital cataract.
- Lens aspiration with anterior vitrectomy with posterior capsulectomy ± IOL is the surgery of choice in congenital cataract.
- ECCE with IOL implantation is the surgery of choice in adult/acquired cataract.
- FLACS—Femtosecond laser—the Newest cataract surgery
- Nd: Glass laser (1053 nm) used for the treatment of cataract,
  Nd: YAG laser (1064 nm) used for treatment of 2° cataract, After cataract or PCO.
- Phacoemulsification works by mechanically (force) breaking nucleus into small pieces.
- Best site for IOL implantation—In the capsular bag
- Ectopia lentis—Marfan syndrome—ST, Homocystinuria—IN, Weill-Marchesani syndrome—anterior and inferior.
- **Hydrophobic acrylic—Biconvex design—Best IOL**
- **Blumenthal technique**—used for performing SICS.

IMAGE-BASED QUESTIONS

There are multiple probable questions that can be asked on a single image.

Question numbers 1 and 2 are based on Image 1.

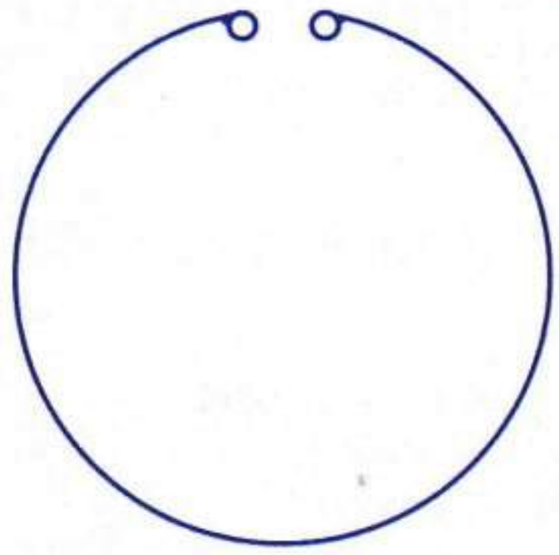


Image 1

1. Identify the optical instrument.
   a. Iris claw IOL
   b. Scleral fixated IOL
   c. Capsular tension ring
   d. Intracorneal stormal ring
2. The optical instrument may be of use in all of the following except
   a. Homocystinuria
   b. Zonular dialysis
   c. Myopia of 1D
   d. Trauma

Question numbers 3 and 4 are based on Image 2.

Image 2

3. What surgical complication is more common in the cataract seen in the above image?
   a. Posterior capsular rupture
   b. Posterior capsular opacification
   c. Suprachoroidal hemorrhage
   d. Cystoid Macular edema
4. Which of the statements is most likely to be false regarding the above cataract?
   a. Associated with remnants of vascular hyaloid system
   b. Typically inherited as autosomal recessive trait
   c. It is congenital
   d. The gene is mapped to the long arm of chromosome 11

Question number 5 is based on Image 3.

Image 3

5. The patient in the image is a 65 year old male, complaints of gradual painless loss of vision. On examination, visual acuity in right eye is 3/60, fundus is not visible. What is the most likely diagnosis?
   a. Retinoblastoma
   b. Mature senile cataract
   c. Phacomorphic glaucoma
   d. Morgagnian cataract

Question number 6 is based on Image 4.

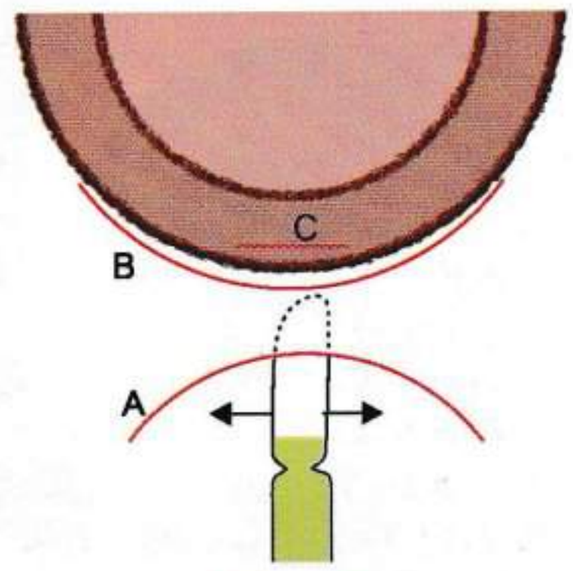


Image 4

6. Which cataract surgery is being done if the incision has been given at point A?
   a. Femtosecond laser cataract surgery
   b. Small incision cataract surgery
   c. Phecoemulsification
   d. ICCE

Question numbers 7 to 9 are based on Image 5.

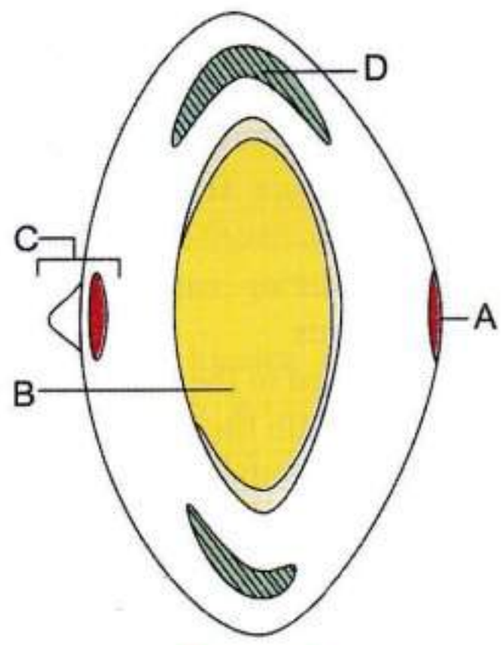


Image 5

Most Recent Image-based Questions of 2019-2017 are given at the end

7. **Identify the type of opacity marked as C in the image.**
   a. Anterior polar cataract
   b. Reduplicated cataract
   c. Imprint cataract
   d. Posterior polar cataract
8. **Mittendorf dots may be associated with**
   a. A
   b. B
   c. C
   d. D
9. **Match the following – all true except**
   a. A – posterior polar cataract
   b. B – lamellar cataract
   c. C – anterior polar cataract
   d. D – coronary cataract

Question numbers 10 and 11 are based on Image 6.

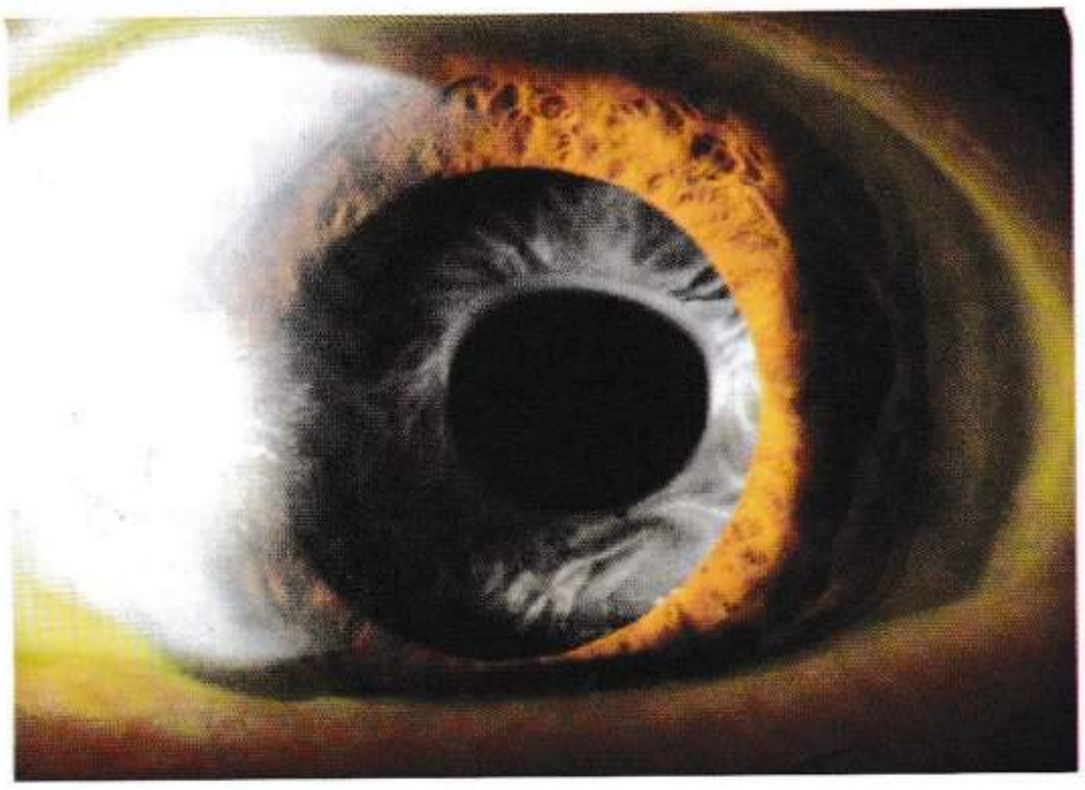


Image 6

10. **A 65 year old male patient presents with symptoms of glare and sensation of peripheral hazy vision, more pronounced at night. He gives history of cataract surgery 3 months back. On examination the above image is seen. Which of the following is the most likely cause of the symptoms?**
    a. Anterior capsular phimosis
    b. Posterior capsular opacification
    c. Lost lens syndrome
    d. Pseudophakic bullous keratopathy
11. **All of the following are true about the ocular pathology (complication of cataract surgery) shown in the image, except**
    a. Nd:YAG laser anterior capsulotomy can be done in symptomatic patients
    b. The severity is related to the optic material of IOL
    c. It usually occurs within the first week after cataract surgery
    d. It occurs more commonly in patients with underlying exfoliation syndrome

Question number 12 is based on Image 7.

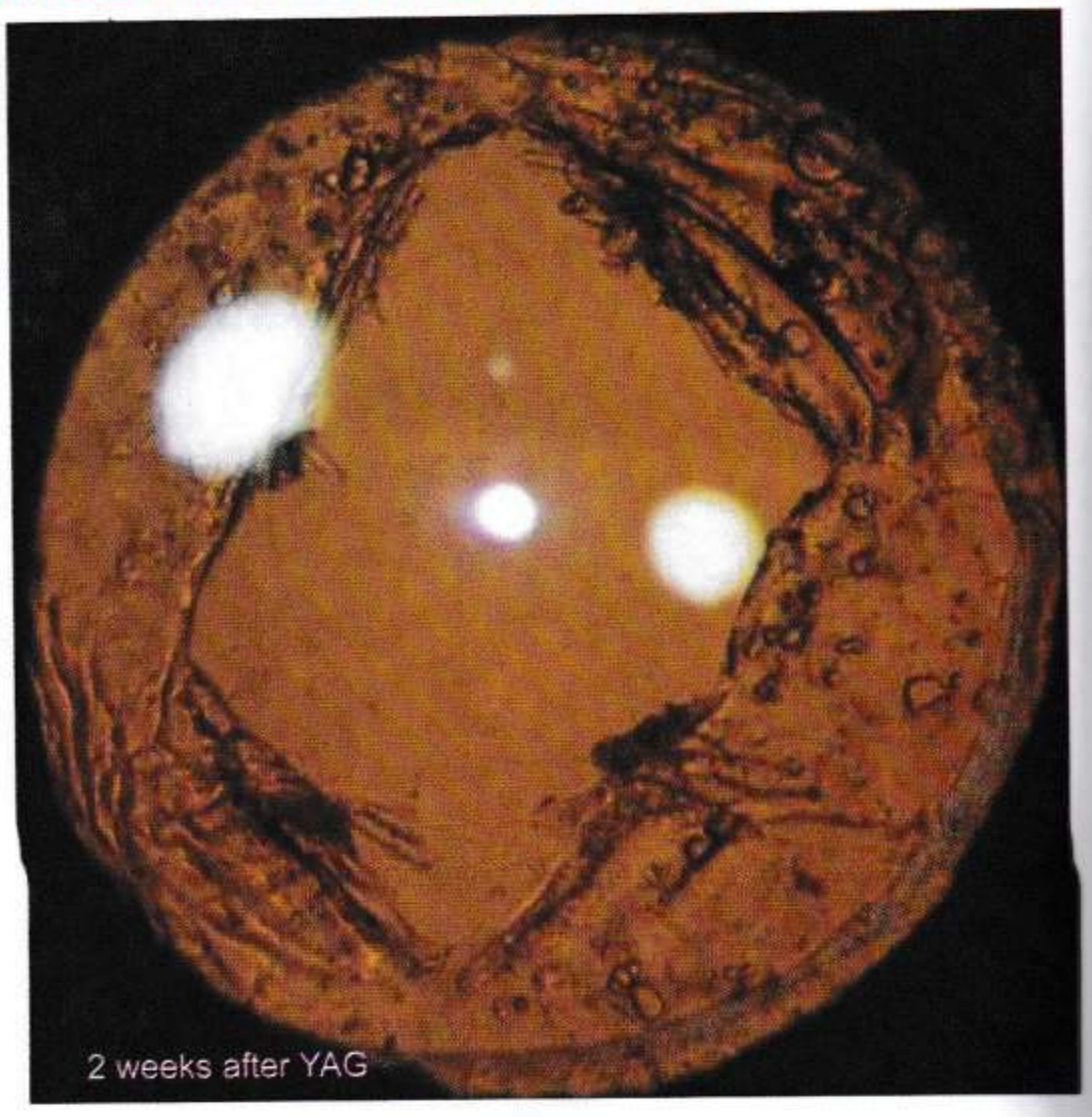


Image 7

12. **Procedure done in the eye (image) uses which of the following lasers**
    a. Argon green laser
    b. Nd:YAG laser
    c. Diode laser
    d. Femtosecond laser

Question number 13 is based on Image 8.

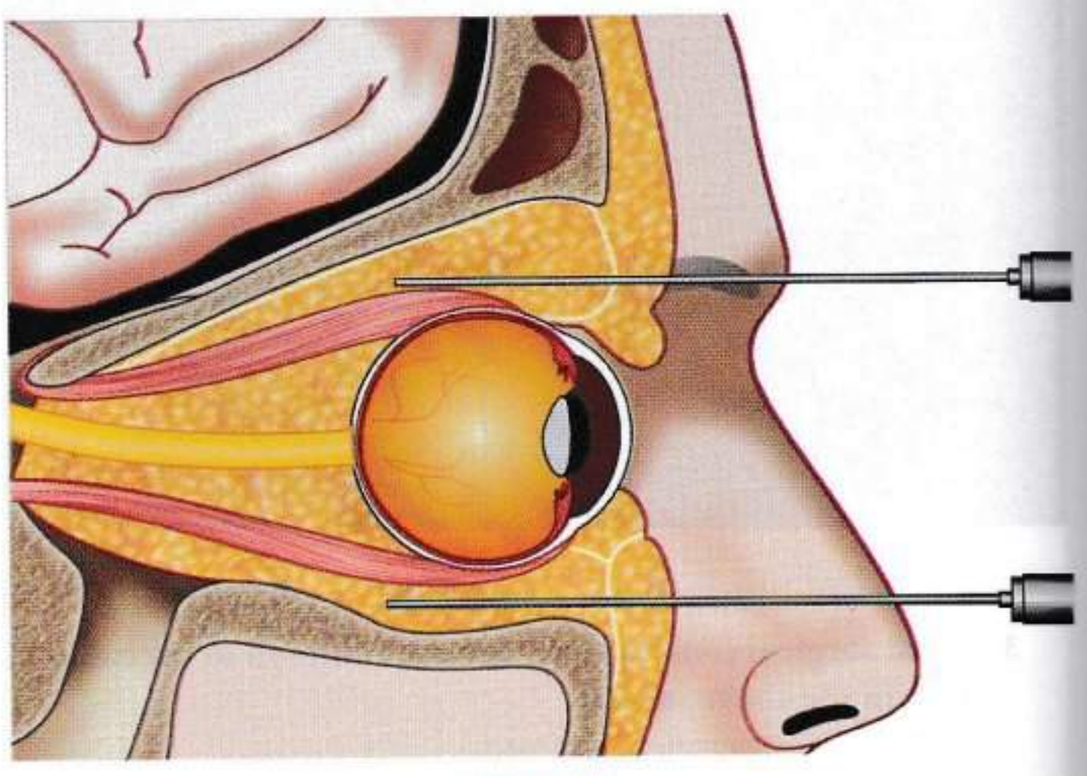


Image 8

13. **Which route of rug administration has been shown in the image?**
    a. Peribulbar block
    b. Retrobulbar block
    c. Facial block
    d. Sub-tenon block

Most Recent Image-based Questions of 2019-2017 are given at the end

Question number 14 is based on Image 9.

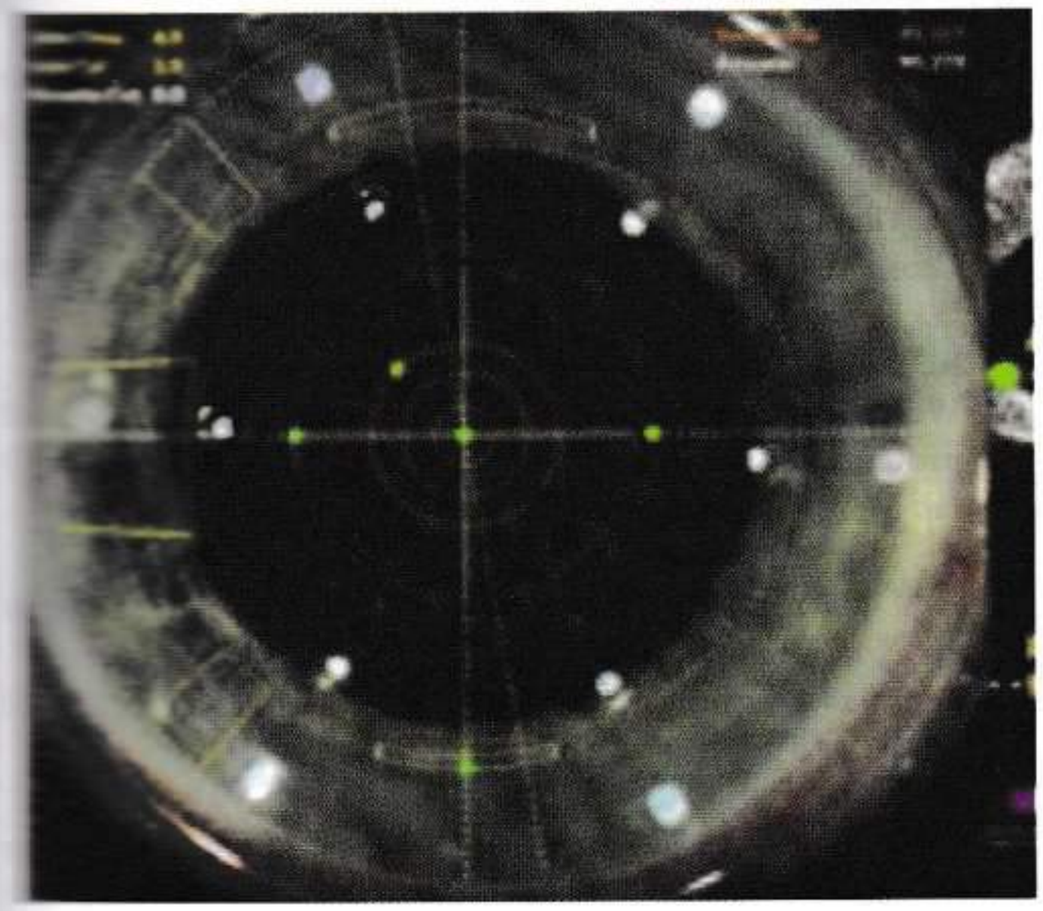


Image 9

14. With advancement cataract surgery is performed with the aid of lasers resulting in smaller incisions and fewer postoperative complications. What is the frequency of laser used in the procedure shown above? *(AIIMS Nov 2016)*
   a. 10^{-9}
   b. 10^{-15}
   c. 10^{-12}
   d. 10^{-6}

Question number 15 is based on Image 10.

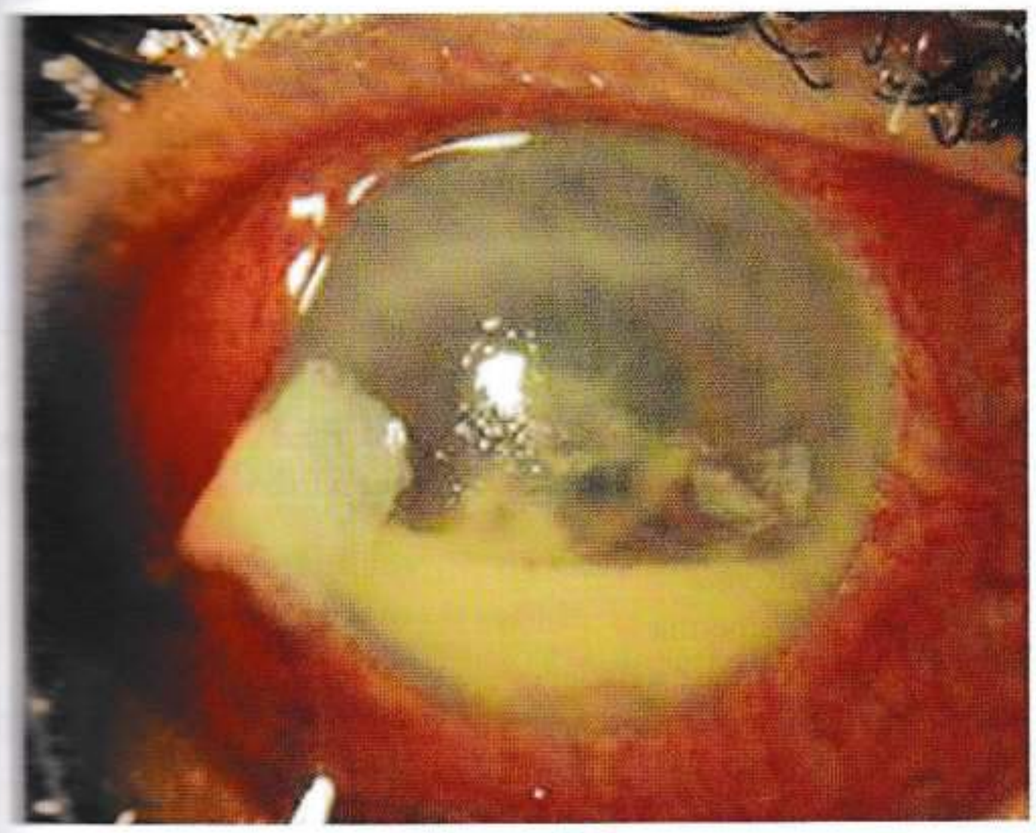


Image 10

15. The patient developed pain and severe loss of vision 36 hours after cataract surgery. On examination the following was seen. Which of the following is the least useful for treatment of the given pathology? *(AIIMS Nov 2017)*
   a. Topical antibiotics
   b. Intravitreal antibiotics
   c. Systemic antibiotics
   d. Pars plana vitrectomy

Question number 16 is based on Image 11.

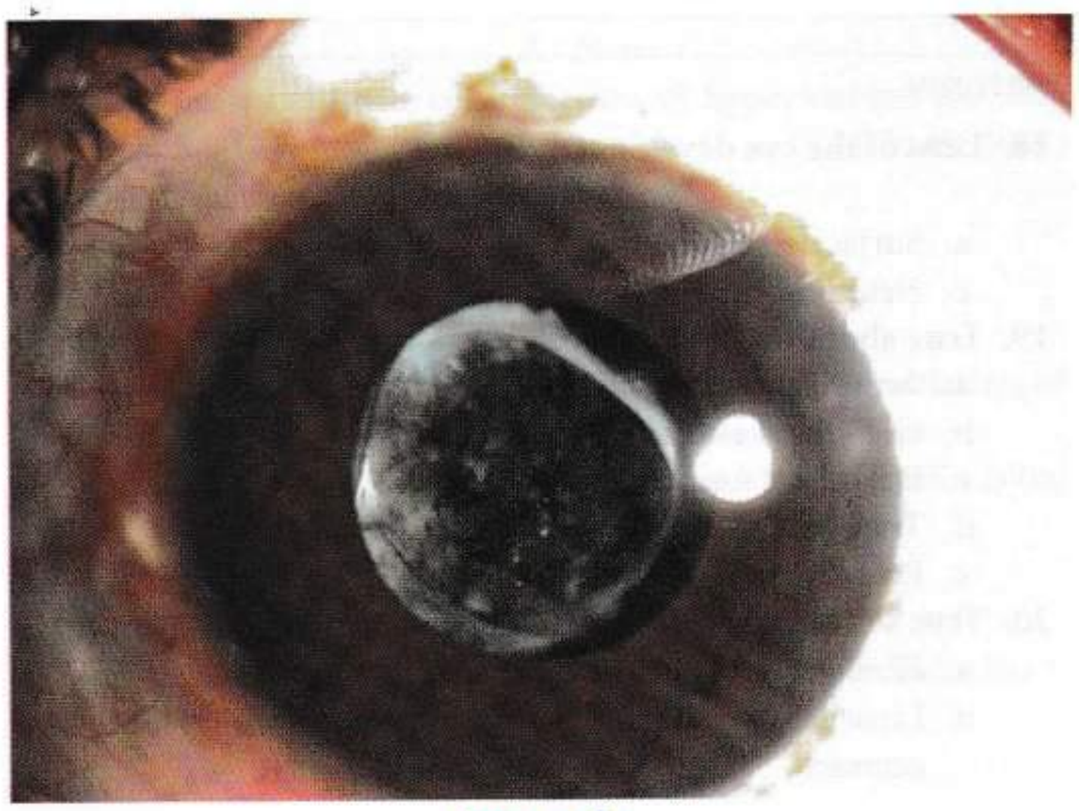


Image 11

16. A 60 year old male gives history of cataract surgery 1 year back. He now complaints of diminished vision and on slitlamp examination the following finding are seen. What is the most likely cause of his loss of vision? *(AIIMS May 2017)*
   a. Irvin gass syndrome
   b. After cataract
   c. UGH syndrome
   d. Endophthalmitis

Most Recent Image-Based Questions of 2019-2017

Question number 17 is based on Image 12.

Image 12

17. A 60 year old male, known case of diabetes underwent a cataract surgery. 36 hours after surgery the patient presents with the following picture. What is the first line of management? *(Recent pattern 2018)*
   a. Intravitreal antibiotics
   b. Pad and bandage
   c. High dose steroids
   d. Topical antibiotics

Most Recent Image-based Questions of 2019-2017 are given at the end

MULTIPLE CHOICE QUESTIONS

Anatomy

18. Lens of the eye develops from *(Recent pattern Nov/Dec 2016)*

a. Surface ectoderm b. Mesoderm
c. Neural ectoderm d. Neural crest derivatives

19. True about lens of eye: *(PGI May 2015)*

a. Avascular
b. Growth takes place throughout life
c. Derives its nutrition from aqueous humor
d. Transparent
e. Ectodermal in origin

20. True statement about crystalline lens: *(PGI Nov 2011)*

a. Fibers of fetal nucleus meet around sutures
b. Lamellar cataract is the most common type of congenital cataract
c. In Blue dot cataract vision is severely impaired
d. Translucent in nature
e. Can not be removed surgically

21. Water content in lens is – *(Recent pattern Nov/Dec 2016)*

a. 64% b. 35%
c. 1% d. 28%

22. Equatorial diameter of the lens is– *(All India pattern Dec 2004)*

a. 7 mm b. 8 mm
c. 9 mm d. 10 mm

23. Lens contains the oldest cells in – *(AIIMS May 2002)*

a. Nucleus
b. Anterior surface of lens
c. Posterior surface of lens
d. Nucleo-cortical junction

24. Strongest attachment of Zonule is at– *(Recent pattern Nov/Dec 2016)*

a. Equator b. Just anterior to equator
c. Posterior to equator d. Posterior lobe

25. Lens capsule is thinnest at: *(JIPMER 2015)*

a. Anterior pole
b. Posterior pole
c. Equator
d. Pupillary margin

26. Which continues to grow in a lifetime?

a. Cornea b. Lens
c. Iris d. Retina

Physiology

27. The major function of major intrinsic proteins 26 (MIP-26) is: *(AII India 2008)*

a. Glucose transport in lens
b. Transport of water in lens
c. Diffusion barrier
d. Capsule of lens

28. Transport of Ascorbic acid to lens is done by: *(All India 2007)*

a. Myoinositol b. Choline
c. Taurine d. Na-K ATPase

29. Which of the following does not handle the oxidative damage in lens? *(All India 2007)*

a. Vitamin A b. Vitamin C
c. Glutathione d. Catalase

30. Lens antigen are? *(Recent pattern Nov/Dec 2016)*

a. Neoantigen b. Sequestrated antigen
c. Altered antigen d. Cross reacting antigen

31. Which of the following is true regarding concentration of proteins in senile cataract? *(AIIMS Nov 2013)*

a. More soluble protein, less insoluble protein
b. More insoluble protein, less soluble protein
c. Equal concentration of both soluble and insoluble proteins
d. None of the above

32. Lens has a respiratory quotient of: *(NIMHANS 2015)*

a. 1 b. 0.6
c. 0.7 d. 0.9

33. High molecular weight proteins in cataractous lens seen only in humans: *(AIIMS May 2015)*

a. HM 1 and 2 b. HM 2 and 3
c. HM 2 and 4 d. HM 3 and 4

34. Which of the following statements is false regarding the aging human crystalline lens?

a. Increase in phosphorylated chains of alpha crystallins in lens fibers
b. Cross-linking of proteins by disulfide bond formation
c. Increase in the reduced form of glutathione
d. HM fractions grow into cell cytoplasm

35. The normal aging human crystalline lens

a. Develops an increasingly curved shape, resulting in more refractive power
b. Develops an increasingly flatter shape, resulting in less refractive power
c. Undergoes an increase in index of refraction as a result of decreasing presence of insoluble protein particles
d. Undergoes an decrease in index of refraction as a result of decreasing presence of insoluble protein particles

Acquired Cataract

36. A 6 month old baby presents with bilateral cataract. A urine test is requested to suspect: *(Recent pattern Nov/Dec 2016)*

a. Homocystinuria
b. Galactosemia
c. Hyperlysinemia
d. Sulfite oxidase deficiency

37. Select the correct match: *(PGI May 2013)*

a. Wilson disease-sunflower cataract
b. Alport syndrome-posterior lenticonus
c. Amiodarone-anterior subcapsular cataract
d. Myotonic dystrophy-Christmas tree
e. Down syndrome-Cortical cataract

38. Which of the following is the only reversible cataract? *(Recent pattern Nov/Dec 2016)*

a. Senile cataract b. Cataract in galactosemia
c. Congenital cataract d. None

Most Recent Questions of 2019-2017 are given at the end

39. **Posterior subcapsular stellate cataract is seen in** *(NIMHANS 2016)*
   a. Wilson's disease b. DM
   c. Myotonic Dystrophy d. SLE
40. **Sunflower cataract is seen in?** *(Recent pattern 2014)*
   a. Galactosemia b. Diabetes mellitus
   c. Chalcosis d. Hereditary polyposis
41. **All of the following associations are true, except** *(Recent pattern Nov/Dec 2016)*
   a. Wilson's disease-Sunflower cataract
   b. Myotonic dystrophy-Christmas tree cataract
   c. Acute Congestive Glaucoma- Glaukomflecken
   d. Galactosemia- Blue dot cataract
42. **Most common type of senile cataract–** *(Recent pattern 2013)*
   a. Cunieform b. Nuclear
   c. Cupuliform d. None
43. **Yellow colour of nuclear cataract due to deposition of–** *(Recent pattern Nov/Dec 2016)*
   a. Urochrome b. Copper
   c. Iron d. Silver
44. **Which morphological type of cataract is most visually handicapping?** *(AIIMS Nov 2002)*
   a. Cortical b. Nuclear
   c. Posterior subcapsular d. Zonular
45. **A male 30 years of age complaints of poor vision in day light which improves in dim light. Which of the following is the most common cause?** *(Recent pattern 2014)*
   a. Cortical cataract b. Morgagnian cataract
   c. Nuclear cataract d. Steroid induced cataract
46. **Second sight phenomenon is seen in–** *(Recent pattern Nov/Dec 2016)*
   a. Nuclear cataract b. Cortical cataract
   c. Senile cataract d. Iridocyclitis
47. **Polyopia/diplopia is seen in which type of cataract–** *(Recent pattern Nov/Dec 2016)*
   a. Nuclear b. Cortical
   c. Posterior subcapsular d. Anterior polar
48. **Fluctuating refractive errors with cataract are seen in–** *(Recent pattern 2014)*
   a. Morgagnian cataract b. Diabetic cataract
   c. Intumescent cataract d. Traumatic cataract
49. **Cataract in patients of diabetes mellitus is due to accumulation of–** *(Recent pattern 2015)*
   a. Glycated crystallins b. Calcified crystallins
   c. Glycated fibrillins d. Calcified fibrillins
50. **Polychromatic lusture is seen in–** *(Recent pattern Dec 12, AI 2004)*
   a. Complicated cataract b. Diabetes mellitus
   c. Post-radiation cataract d. Congenital cataract
51. **"Bread-crumb" appearance is seen in–** *(Recent pattern 2013)*
   a. Diabetic cataract b. Toxoplasmosis
   c. CMV retinitis d. Complicated cataract
52. **Oil drop cataract is characteristic of–** *(Recent pattern Nov/Dec 2016)*
   a. Diabetes b. Chalcosis
   c. Galactosemia d. Wilson's disease
53. **Rosette cataract seen in?** *(Recent pattern 2014)*
   a. Ocular trauma b. Diabetes
   c. Wilsons d. None
54. **The most common complication of hypermature sclerotic cataract is:** *(All India 2004)*
   a. Dislocation of the lens
   b. Phacomorphic glaucoma
   c. Uveitis
   d. Neovascularization of retina
55. **A diabetic patient gets cataract because of accumulation of sorbitol in lens. The enzyme responsible for this is:**
   a. Glucokinase *(AIIMS Nov 2008, All India 2006)*
   b. NADPH+ dependent aldose reductase
   c. Phosphofructoisomerase
   d. Hexokinase
56. **Hypermature cataract leads to:** *(All India 2010)*
   a. Phacomorphic glaucoma
   b. Phactoxic glaucoma
   c. Phacolytic glaucoma
   d. None of the above
57. **Complicated cataract is seen in:** *(Recent pattern 2014)*
   a. Blunt trauma b. Diabetes mellitus
   c. Retinitis pigmentosa d. Myopic chorioretinitis
58. **Cupuliform cataract arises from ?** *(Recent pattern Aug 2012)*
   a. Posterior capsule b. Anterior capsule
   c. Posterior cortex d. Anterior cortex
59. **Complicated cataract occurs at?** *(Recent pattern Aug 2012)*
   a. Posterior capsule b. Anterior capsule
   c. Posterior cortex d. Anterior cortex
60. **An infant with intolerance to breast feed, vomiting and diarrhoea develops cataract. Which of the following is the most likely diagnosis?** *(Recent pattern 2016)*
   a. Lowe syndrome b. Galactosemia
   c. Fabry disease d. Congenital hypoglycemia
61. **Onion ring appearance is seen in which of the following** *(Recent pattern Nov/Dec 2016)*
   a. Posterior subcapsular cataract
   b. Posterior polar cataract
   c. Galactosemia
   d. Zounlar cataract
62. **The earliest change in the cortical cataract is**
   a. Presence of lens vacuoles
   b. Presence of increased amount of urochrome pigment
   c. Presence of nucleated epithelial cells posterior to the equator
   d. Presence of lamellar separation
63. **The following metabolic state is associated with cataract**
   a. Hyperlysinemia
   b. Hypoglycemia
   c. Uremia
   d. Hypercalcemia
64. **The histological features of the following are true**
   a. Elschnig pearls – proliferation of the lens epithelium on the anterior capsule
   b. Posterior subcapsular cataract – bladder cells
   c. Glauckomflecken – wedl cells
   d. Soemmering ring – sequestration of proliferating lens fibers on the posterior capsule

Most Recent Questions of 2019-2017 are given at the end

65. **In which of the following condition frequent change of specatcles is seen**
   a. Morgagnian cataract
   b. Incipient cataract
   c. Primary open angle glaucoma
   d. Presbyopia

66. **The molecule which is the initiator of cataract formation in the lens of the eye and whose 1-phosphate derivative is responsible for liver failure is** *(AIIMS Nov 2002)*
   a. Sorbitol
   b. Galactitol
   c. Inositol
   d. Mannitol

Congenital Cataract

67. **Congenital cataract should be diagnosed and treated before?** *(Recent pattern 2014)*
   a. 8 weeks
   b. 12 weeks
   c. 16 weeks
   d. 32 weeks

68. **An infant presents with bilateral white pupillary reflex. On slit lamp examination a zone of opacity is observed around the fetal nucleus with spoke like radial opacities. The most likely diagnosis is:** *(All India 2012)*
   a. Cataracto centralis pulverulenta
   b. Lamellar cataract
   c. Coronary cataract
   d. Posterior polar cataract

69. **Minimum vision loss with which cataract–**
   a. Blue dot cataract *(Recent pattern Dec 2012)*
   b. Zonular cataract
   c. Anterior polar cataract
   d. Posterior polar cataract

70. **Most common congenital cataract associated with visual defect–** *(Recent pattern Dec 2012)*
   a. Punctate Cataract
   b. Blue dot cataract
   c. Zonular cataract
   d. Fusiform cataract

71. **Most common type of congenital cataract is–** *(Recent pattern Dec 2012)*
   a. Capsular
   b. Zonular
   c. Coralliform
   d. Blue dot

72. **Rider's cararact is seen in –** *(Recent pattern 2014)*
   a. Blue dot cataract
   b. Zonular cataract
   c. Anterior capsular cataract
   d. Coronary cataract

73. **A child has got a congenital cataract involving the visual axis which was detected by the parents right at birth. This child should be operated–** *(DPG 10, AI 2003)*
   a. Immediately
   b. At 2 months of age
   c. At 1 year of age when the globe becomes normal sized
   d. After 4 years when entire ocular and orbital growth becomes normal

74. **Surgery of choice for congenital cataract–** *(Recent pattern 2013)*
   a. ECCE
   b. ICCE
   c. Needling
   d. Discission

75. **Gene commonly indicated in congenital cataract–** *(AIIMS Nov 2014)*
   a. CRYGS3
   b. PAX6
   c. PITX3
   d. LMX1B

76. **Rubella cataract is seen as–** *(JIPMER 2009)*
   a. Posterior polar cataract
   b. Nuclear cataract
   c. Blue dot cataract in young
   d. Cuneiform cataract

77. **The following statement about ocular effects of congenital rubella syndrome is false**
   a. Myopia is common
   b. Lamellar cataract is not most common
   c. Ocular defect typically occurs with infection in the first trimester
   d. It can cause salt and pepper fundus

78. **In congenital cataract**
   a. Patients with severe bilateral cataract should have the cataracts removed before 3 weeks of age
   b. The posterior capsule is usually left intact
   c. Visual prognosis is good in patients who develop nystagmus
   d. Postoperative visual acuity is worse in patients with unilateral cataract than bilateral cataract

79. **Which of the following is true regarding Mittendorf dot?**
   a. Glial tissue projecting from optic disc
   b. Obliterated vessel running forward into the vitreous
   c. Associated with posterior polar cataract
   d. Commonest congenital anomaly of hyaloid system

Treatment of Cataract – Surgeries and Complications

80. **Posterior capsular cataract is treated by which laser?** *(Recent pattern 2013, AI 2015)*
   a. Argon laser
   b. CO_2 laser
   c. Excimer
   d. Nd:YAG

81. **In a district hospital in India, an ophthalmologist is expected to perform which of the following surgeries most commonly?** *(AIIMS May 2013)*
   a. Trabeculectomy
   b. Phacoemulsification
   c. Dacryocystectomy
   d. Bilamellar tarsal rotation

82. **Ring of soemmering is seen** *(Recent pattern 2013-14)*
   a. Wilson's disease
   b. Retinitis pigmentosa
   c. Siderosis bulbi
   d. Lens capsule

83. **Common procedures for cataract in adult includes:** *(PGI Nov 2011)*
   a. Phacoemulsification with posterior capsulotomy with IOL implant
   b. Phacoemulsification with corneo-scleral incision with IOL implant
   c. ECCE with IOL implant
   d. ICCE with IOL implant
   e. ECCE without IOL implant

84. **Postcataract infection can be prevented by:** *(PGI May 2010)*
   a. Preoperative oral antibiotics
   b. Postoperative oral antibiotics
   c. Intraoperative IV antibiotics
   d. Postoperative topical antibiotics

Most Recent Questions of 2019-2017 are given at the end

Advantage of continuous curvilinear capsulorhexis over can opener technique : *(PGI Nov 2016)*

a. Preferred method of anterior capsulotomy in phacoemulsification
b. More chances of posterior capsular opacification
c. Keeps the nucleus in place
d. Resists radial tears
e. Helps in stabilizing and centering the lens implant

The investigation to predict postoperative visual outcome after cataract surgery is *(Recent pattern 2016)*

a. Pachymetry b. Topography
c. Potential acuity meter d. Lensometry

Which of the following is not needed for IOL power calculation prior to cataract surgery? *(Recent pattern 2016)*

a. Keratometry b. A-Scan biometry
c. Corneal topography d. SRK formula

Best site of IOL implantation– *(Recent pattern 2013)*

a. Iris b. Capsular bag
c. Anterior chamber d. Sulcus

Most common complication of extracapsular cataract surgery is– *(Recent pattern 2015)*

a. Retinal detachment
b. Opacification of posterior capsule
c. Vitreous hemorrhage
d. None

Wavelength of Nd: YAG laser *(PGI June 2007)*

a. 1040 nm b. 1040 mm
c. 1064 cm d. 1064 nm

Foldable intra ocular lens is made up of? *(Recent pattern Nov 2016)*

a. PMMA b. Ethylene
c. Polypropylene d. Acrylic

Best way to prevent infection after cataract surgery is *(Recent pattern 2016, AI 2013-14)*

a. Antibiotics b. Eye brows shaving
c. Through irrigation d. None of the above

Axial length of eye for cataract surgery is measured by which of the following?

a. Keratometer b. A-scan biometry
c. Specular microscope d. Slit lamp biomicroscopy

Which of the following is the latest cataract surgery *(Recent pattern Dec 2016)*

a. ICCE b. Phacoemulsification
c. Femtosecond laser d. Phaco-nit

UGH syndrome is commonly due to *(Recent pattern Nov 2016)*

a. ACIOL b. PCIOL
c. Several fixed IOL d. Piggy back IOL

Blumenthal technique is employed in

a. Cataract extraction
b. Fluorescein angiography
c. Trabeculectomy
d. Gonioscopy

Which agent is most appropriate for staining the anterior lens capsule in preparation for creating a capsulorrhexis in a patient with a poor red reflex?

a. Fluoroscein sodium b. Methylene blue
c. Rose Bengal d. Trypan blue

Power for nuclear fragmentation in phacoemulsification– *(Recent pattern 2016)*

a. Ultrasonic b. Mechanical
c. Thermal d. Fluid

Ectopia Lentis

Typically bilateral inferior lens subluxation of the lens is seen in: *(All India 2006)*

a. Marfan's syndrome b. Homocystinuria
c. Hyperinsulinemia d. Ocular trauma

Which of the following is combination is/are true about ectopia lentis: *(PGI May 2016)*

a. Superior temporal displacement- Marfan syndrome
b. Inferior temporal displacement- Homocystinuria
c. Inferior nasal displacement- Homocystinuria
d. Downwards and temporal sublaxaion- Weil-Marchesani syndrome

Ectopia Lentis is/are associated with: *(PGI Nov 2015)*

a. Homocystinuria b. Alport syndrome
c. Lowe syndrome d. Marfan syndrome
e. Sulphite oxidase deficiency

Not true about Ectopia lentis in Marfan syndrome:

a. Inferior nasal displacement of lens *(PGI Nov 2014)*
b. Lens is displaced down and outward
c. Lens displaced upwards and temporally
d. Anterior dislocation of the lens into the pupil or anterior chamber may cause pupillary block with acute glaucoma
e. Posterior dislocation can cause harmful vitreous traction on the retina

Ectopia lentis is/are seen in : *(PGI May 2013)*

a. Maple syrup disease b. Homocystinuria
c. Ehler Danlos syndrome d. Myotonic dystrophy
e. Sulfite oxidase deficiency

Ectopia lentis is/are seen in: *(PGI May 2012)*

a. Marfan syndrome b. Homocystinuria
c. DM d. Hypertension
e. Sulfite oxidase deficiency

Ectopia lentis is seen in: *(PGI Nov 2010)*

a. Marfan's syndrome b. Congenital rubella
c. Homocystinuria d. Sulfite oxidase deficiency
e. Myotonic dystrophy

In Marfan's syndrome lens dislocation is commonly seen– *(Recent pattern 2014)*

a. Upwards b. Downwards
c. Superotemporally d. Nasally

Traumatic dislocation of lens is diagnosed by:

a. Direct ophtalmoscopy
b. Indirect ophthalmoscopy
c. Distant direct ophthalmoscopy
d. Slit lamp examination

A patient presents to the emergency department with uniocular diplopia. Examination with oblique illumination shows golden crescent while examination with co-axial illumination show a dark crescent line. Which of the following is the most likely diagnosis. *(All India 2012)*

a. Lenticonus b. Coloboma
c. Microspherophakia d. Ectopia lentis

Most Recent Questions of 2019-2017 are given at the end

Miscellaneous

109. Least affected cranial nerve in retro-orbital block: *(PGI May 2013)*

a. 1 CN b. 2 CN
c. 3 CN d. 4 CN
e. 6 CN

110. Lens is derived from? *(Recent pattern 2013)*

a. Endoderm
b. Surface ectoderm
c. Lambert Eaton syndrome
d. Hyperthyroidism

111. Normal axial length of the eye

a. 18 mm b. 20 mm
c. 24 mm d. 28 mm

112. Cataract is associated with which of the following metabolic disease? *(Recent pattern 2013)*

a. Galactosemia b. Phenylketonuria
c. Fructosuria d. Pentosuria

113. Cause of Cataract *(PGI May 2010)*

a. Infrared rays b. Microwaves
c. UV rays d. Obesity

114. Anterior lenticonus is found in– *(Recent pattern 2014)*

a. Lowe's syndrome b. William's syndrome
c. Alport's syndrome d. Down's syndrome

115. Fincham test is used to diagnose *(Recent pattern 2015)*

a. Open angle glaucoma
b. Cataract
c. Mucopurulent conjunctivitis
d. Acute angle closure glaucoma

116. Spontaneous absorption of the lenticular material is seen in:

a. Myotonic dystrophy
b. Hallermann-Streiff syndrome
c. Aniridia
d. Persistent hyperplastic primary vitreous

117. Chronic systemic steroid use causes:

a. Open angle glaucoma
b. Conjunctival and lid papillomatosis
c. Uveitis
d. Cataract

118. How is posterior segment examined in mature cataract?

a. Laser interferometry *(Recent pattern Nov 2016)*
b. Optical coherence tomography
c. B scan
d. A scan

119. Which component of the eye has maximum refractive index?

a. Posterior surface of the lens
b. Anterior surface of the lens
c. Cornea
d. Centre of the lens

120. The following is not true about microspherophakia

a. It is associated with hypermetropia
b. It can be an autosomal recessive disorder
c. Anterior dislocation is known as a complication
d. It is associated with short stature and stiff joints

121. Cataract can be produced in experimental animals by depriving them of which amino acid

a. Leucine b. Tryptophan
c. Lysine d. Tyrosine

122. The antero-posterior diameter of the lens is increased in all except

a. Intumescent cataract
b. Accommodation
c. Weill-Marchesani syndrome
d. Morgagnian cataract

123. Which of the following does not involve lens capsule?

a. Siderosis bulbi
b. Vossius ring
c. Glaukomflecken
d. Chalcosis bulbi

124. Which of the following ATT drugs is associated with cataract? *(AIIMS Nov 2015)*

a. Isoniazid b. Rifampicin
c. Pyrazinamide d. Ethambutol

125. IOL power was calculated to be +22.00 D for a planned cataract surgery with PCIOL implantation. An IOL of 20.00D was placed in the capsular bag due to unforeseen circumstances. What will be the post operative refractory status of the patient?

a. Myopia b. Myopic astigmatism
c. Hyperopic astigmatism d. Hypermetropia

Most Recent Questions of 2019-2017

126. A 55 year old male with vision 6/12 in both eyes, complaints of Glare at night, especially while driving. What could be the possible diagnosis? *(AIIMS May 2018)*

a. Diabetic retinopathy
b. Age related macular degeneration
c. Corneal degeneration
d. Opacification of lens

127. Which of the following is/are true about secondary cataract

a. Treatment of thickened capsule can be done by discission with cystitome *(PGI May 2017)*
b. Treatment by Nd:YAG laser posterior capsulotomy
c. More common after intracapsular cataract extraction than extracapsular cataract extraction
d. Posterior capsular opacification (PCO)
e. Anterior subcapsular cataract

128. Cataract in infancy is associated with all of the following except *(PGI May 2018)*

a. Hypoglycemia b. Zellweger syndrome
c. Canavan syndrome d. Reiger syndrome

129. Post operative endophthalmitis in cataract surgery can be prevented by use of: *(PGI May 2017)*

a. Preoperative oral antibiotics
b. Intraoperative Intracameral antibiotics
c. Use of povidone-iodine solution to paint the lids before surgery
d. Cleaning and sterilization of operation theatre
e. Postoperative topical antibiotics

130. Dislocation of lens not seen in *(PGI Nov 2017)*

a. Ehler danlos syndrome b. Sulfatase deficiency
c. Galactosemia d. Marfan syndrome
e. Homocystinuria

131. Christmas tree cataract is seen in *(Recent question June 2018)*

a. Down's syndrome b. Trauma
c. Diabetes mellitus d. Myotonic dystrophy

Most Recent Questions of 2019-2017 are given at the end

ANSWERS TO IMAGE-BASED QUESTIONS

1. Ans. (c) **Capsular tension ring**

2. Ans. (c) **Myopia of 1D**

It is a CTR - **a capsular tension ring**, used to support the the zonules in cases of zonular dehiscence – helpful during surgery and after surgery to hold the IOL-capsular bag in position. It also reduces the incidence of posterior capsular opacification. It may be **used in** the following conditions

- Mild zonular instability – zonulysis less than 4 clock hours
- Mild pseudoexfoliation
- Progressive zonular weakness as in homocystinuria
- Localized zonular dehiscence as in cases of trauma
- In cases of high myopia

Gimmi's ring – CTR designed for scleral fixation with sutures.

3. Ans. (a) **Posterior capsular rupture**

Onion ring appearance – case of Posterior polar cataract (PPC)

Posterior Capsular rupture is more common (26-36% cases), making surgical removal often difficult, because of its adherence to or associated weakness of the posterior capsule.

4. Ans. (b) **Typically inherited as autosomal recessive trait**

Option a – sporadic PPC is typically unilateral and associated with remnants of the tunica vasculosa lentis.

Option b – familial PPC's are bilateral and follow an autosomal dominant pattern of inheritance.

Option d – five genes have been attributed (CRYAB gene on 11q, PIT X 3 gene).

5. Ans. (b) **Mature senile cataract**

6. Ans. (b) **Small incision cataract surgery**

Incision at **point A is a scleral incision** – which means that to enter the anterior chamber – a sclerocorneal tunnel has to be constructed – procedure for SICS.

Best – Frown shaped incision with the convexity 1.5-2 mm behind limbus, centered at 12 o'clock.

Incision at point B – limbal incision – used for conventional ECCE.

Incision at point C – clear corneal incision – preferred in Phacoemulsification and FALCS.

7. Ans. (b) **Reduplicated cataract**

How to identify

Anterior curvature of lens is less than posterior curvature of lens (as anterior curvature of radius is 10 mm and posterior radius of curvature is 6 mm and radius is inversely proportional to curvature) – thus first mark the anterior and posterior pole. So, opacity marked C is present anteriorly.

Option d – ruled out

Option a/c – may be true

Option b – when anterior polar cataract – sometimes pyramidal shaped is present along with anterior subcapsular cataract separated by a clear space in between – known as Reduplicated cataract.

8. **Ans. (a) A**

Mittendorf dots are remnants of tunica vasculosa lentis at its anterior end i.e. the posterior end of the lens – thus causing posterior polar cataract.

9. **Ans. (b) B – lamellar cataract**

A and C already explained.

B – nuclear cataract – not lamellar cataract, as it effects the fetal nucleus with the embryonic nucleus appearing as a clear zone and has associated spoke like Riders.

D – coronary cataract – peripheral cortical cataract.

10. **Ans. (a) Anterior capsular phimosis**

What is visible in the image – margin of the anterior capsular opening (created during ECCE cataract procedures) and the remaining anterior capsule, which are fibrosed and contracted (wrinkled appearance).

Option b – PCO will either present as pearls or as central fibrosis (Sommerring ring), and usually occurs 9-12 months after cataract surgery.

Option c – Patient would have complained of hypermetropia due to decrease in the total refractive power of eye, also capsular bag dislocates alongwith the IOL due to weakening of ciliary zonules.

Option d – *PBK occurs due to iris-clip lenses (ACIOL) which have been associated with an increased incidence of corneal contact during eye movement leading to corneal decompensation.*

11. **Ans. (c) It usually occurs within the first week after cataract surgery**

Option a – Done to enlarge the anterior capsular opening in Symptomatic patients.

Option b – **highest rate** is seen with Plate-haptic silicone PCIOL, **lowest rate** with 3-piece acrylic optic IOL.

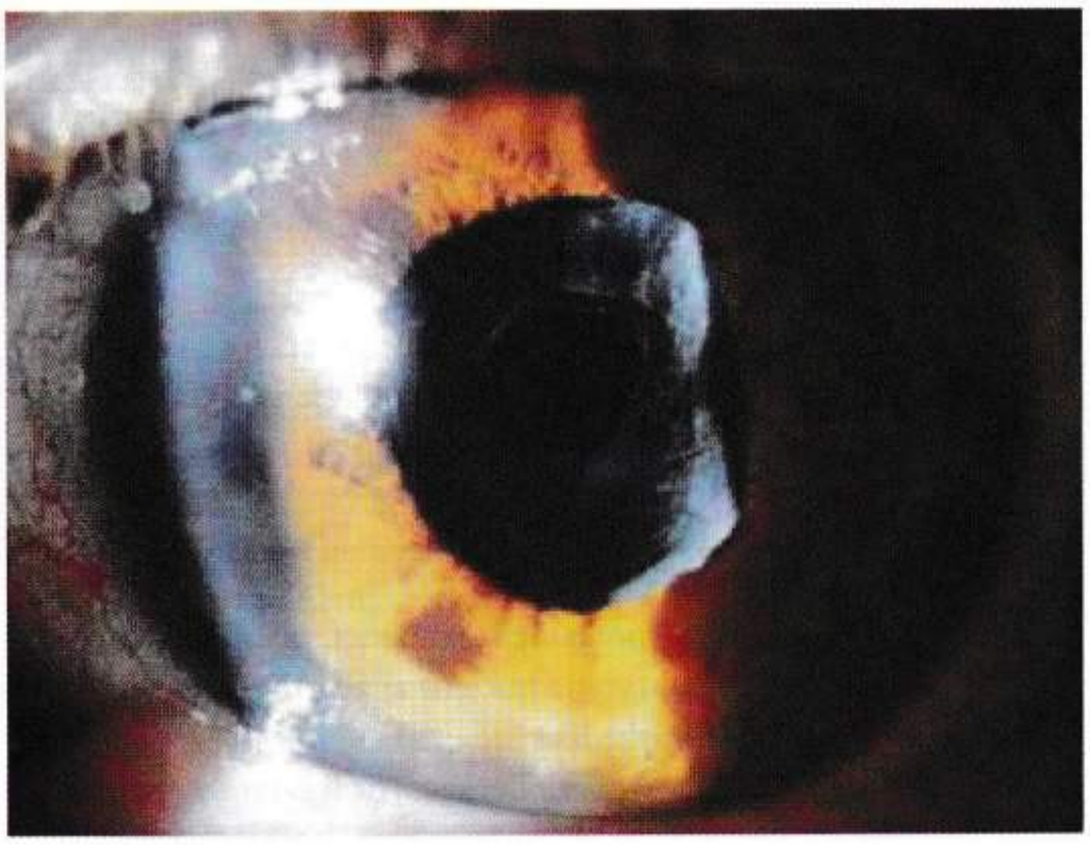
Option c – it usually presents after several weeks to 3 months post surgery – Late complication.

Option d – Phimosis occurs more frequently in

- Smaller CCC openings
- Patients with underlying exfoliation syndrome
- Homocystinuria
- Marfan syndrome
- Trauma

12. **Ans. (b) Nd:YAG laser**

In the image a central opening has been made in the posterior capsule, in the periphery some remnants of Elschnig pearls can be seen. Thus, image shows **a post-posterior capsulotomy picture** in the eye. Posterior capsulotomy is usually done with Nd:YAG laser – Photodisruption.



Central opening in a PCO made with Nd YAG laser

13. Ans. (a) Peribulbar block

In the image two injections can be seen to be given one superiorly and the other inferiorly, and the needle is not seen to be piercing the muscular cone – thus **injection is** being given in the **extraconal compartment** – both these features indicate **Peribulbar route** of drug administration.

Retrobulbar block is given in the intraconal compartment and only inferiorly.

Frontal block is given superiorly at the midpoint of the supraorbital margin along the roof of orbit.

14. Ans. (b) 10^{-15}

Ref: Yanoff & Duker 4/e, p. 375-376; Parson's 22/e, p. 282

Femtosecond laser is an infrared laser with a wavelength of **1053 nm**[Q] and ultra-short pulse duration of **10-15 seconds** (Femtosecond). The main advantage of this ultra-short pulse is that the collateral damage to the tissue surrounding the target tissue is minimal.

The **applications** of femtosecond lasers are:

Femtosecond laser assisted cataract surgery where laser is used for creating the incision, capsulorhexis.

15. Ans. (c) Systemic antibiotics

Ref: American Academy of Ophthalmology, BSCS, Section 11, p. 192; Kanski 7/e, p. 293

Option a – topical antibiotics are of limited help but are initiated after the surgery (ESCRS guidelines, 2013)

Option b – Intravitreal antibiotics are the key to the management.

Option c – Systemic antibiotics are of no benefit. In the EVS (Endophthalmitis Vitrectomy study) no statistical difference in final visual acuity or media clarity between patients who received systemic antibiotics or not.

Option d – EVS showed a benefit for immediate Pars plana vitrectomy in eyes with a visual acuity of perception of light only (PL positive)

16. Ans. (b) After cataract

Ref: Kanski 7/e, p. 295-296

In the image a PCIOL (behind the iris margin) can be seen and posterior to the PCIOL a fibrous opacification is seen, which can be inferred to be opacification of the posterior capsule of lens.

Option a – Irvin Gass syndrome usually occurs 6-10 weeks after surgery

Option b – After cataract (posterior capsule opacification) is the most common late complication of uncomplicated cataract surgery. Presents with reducing visual acuity, contrast sensitivity impairment, glare and mono-ocular diplopia

Option c – UGH syndrome occurs due to ACIOL (commonly)

Option d – Endophthalmitis presents with Hypopyon, Vitreous inflammation, Circumcorneal congestion etc.

17. Ans. (a) Intravitreal antibiotics

Ref: American Academy of Ophthalmology, BSCS, Section 11, p. 192; Kanski 7/e, p. 293

Post cataract surgery, patient is presenting with Hypopyon, corneal edema and redness (congestion). This indicates Acute onset (within 7 days) post operative endophthalmitis.

The treatment of choice is Intravitreal antibiotics. They should be administered immediately after culture specimens have been obtained. Commonly used are Ceftazidime (2mg in 0.1 ml) and Vancomycin (2mg in 0.1 ml)

ANSWERS TO MULTIPLE CHOICE QUESTIONS

18. Ans. (a) Surface Ectoderm

Ref: Khurana Anatomy 2/e, p. 16

19. Ans. All (a), (b), (c), (d) and (e)

Ref: Parson's 22/e, p. 261-62; I. B. Singh Embryology 10/e, p. 356

- *"The lens of the eye is developed from a thickened area of surface ectoderm, the lens placode"*
- *"The lens grow in size continuously throughout life, in this respect it is unique among the organs of the body. At birth its weight is about 65 mg & by 80 years of age it has been found to weigh 258 mg"*

20. Ans. (a) Fibers of fetal nucleus meet around sutures

Ref: Khurana 6/e, p. 184; Parson's 22/e, p. 270

- **Fetal nucleus**
  Its *fibers meet around sutures which are anteriorly Y-shaped and posteriorly inverted Y-shaped*
- **Blue dot cataract**: Opacities are usually stationary and do not affect vision *(Developmental cataract)*

21. Ans. (a) 64%

Ref: Parson's Ophthalmology 21/e, p. 256

Ans. (d) 10 mm

Ref: Foster 2/e, p. 1912, Khurana Anatomy 2/e, p. 86

Ans. (a) Nucleus

Ref: Parson's 21/e, p. 256-257

Ans. (b) Just anterior to equator

Ref: Khurana Anatomy 2/e, p. 92

- **Orbiculo-anterior capsular fibers**–thickest and **strongest** zonules fibers. Arise from pars plana and get inserted anterior to equator
- **Cilio-posterior capsular fibers**–Most numerous
- **Cilio-equatorial fibres**–become less with advancing age

Ans. (b) Posterior pole

Ref Khurana Anatomy 2/e, p. 86

Ans. (b) Lens

Ref: Khurana Anatomy, 2/e, p. 89

Ans. (b) Transport of water in lens

Ref: American academy of ophthalmology, BCCS, Section 11/ p. 12-13

- MIP is founding member of class of proteins called aquaporin. MIP 26 is also known as aquaporin O.

Ans. (d) Na-K ATPase

Ref: Vitamin C transport in human epithelial cells: evidence for presence of SVCT2; R kannan et al

- Data suggests that ascorbic acid transport in lens epithelium is **mediated by SVCT2** and not SVCT1

Ans. (a) Vitamin A

Ref: Adler's Physiology 10/e, p. 130; Parson's 20/e, p. 248, Harper 27/e, p. 119, 612

Ans. (b) Sequestrated antigen

Ref: Ananthanarayan and Paniker 7/e, p. 171; Textbook of Medical physiology by Khurana 2009 ed. p. 207

- **Hidden/Sequestrated antigen**—certain self antigens present in the close system and are never exposed during fetal life. These are known as hidden antigens e.g. → sperm antigen, lens proteins in capsule.

Ans. (b) More insoluble protein, less soluble protein

Ref: Yanoff 2/e, p. 264; American Academy of Ophthalmology, BSCS, Section 11/p. 15

Ans. (a) 1

RQ is the ratio of CO_2/O_2. In lens it is 1 which indicates that carbohydrates are the main source of energy in lens.

Ans. (d) HM 3 and 4

Ref: https://www.karger.com/Article/Pdf/265046 Aggregation of Proteins in Human Cataract Harding J.J.

34. Ans. (c) Increase in the reduced form of glutathione

Ref: American academy of ophthalmology, BSCS, Section 11/ p. 13

Depletion of reduced form of glutathione accelerates protein cross-linking, protein aggregation and light scattering.

35. Ans. (a) Develops an increasingly curved shape, resulting in more refractive power

Refer text

36. Ans. (b) Galactosemia

Ref: Parson's 22/e, p. 273

Laboratory investigations for the diagnosis of bilateral, non-hereditary pediatric cataract

Blood test

- Serum biochemistry for levels of blood glucose, calcium and phosphorus
- Red blood cell transferase and galactokinase levels
- Serology for estimating the tiers of antibody for infections such as toxoplasmosis, rubella, cytomegalovirus and herpes simplex virus (TORCH) and hepatitis B virus

Urine test

- Urine assay for the **presence of reducing substances after milk feeding (for galactosaemia)**
- Screening for amino acids in the urine (if Lowe syndrome is suspected)

37. Ans. (a) Wil.., (c) Amio.. & (d) Myo..

Ref: Parson's 20/e, p. 249-50; American Academy of Ophthalmology Section 11/p. 56-57

Refer text

38. Ans. (b) Cataract in Galactosemia

Ref: Kanski 7/e, p. 301

Refer Ans. 60.

39. Ans. (c) Myotonic Dystrophy

Ref: Parson's 22/e, p. 282

40. Ans. (c) Chalcosis

Ref: Khurana 4/e, p. 493, Parson's 22/e, p. 396

41. Ans. (d) Galactosemia-Blue dot cataract

42. Ans. (a) Cunieform

Ref: Khurana Anatomy 2/e, p. 105

- Most common type of senile cataract is cunieform cortical (70%) followed by nuclear (25%) and cupuliform.

43. Ans. (a) Urochrome

Ref: Kanski 7/e, p. 71

Refer text

44. Ans. (c) Posterior subcapsular

Ref: Parson's 21/e, p. 258, 260; Kanski 7/e, p. 270

- Due to its location at the nodal point of eye, a PSC opacity causes more profound visual effect than its comparable nuclear cataract.

45. Ans. (d) Steroid induced cataract

Ref: Ducker's ophthalmology 2/e, p. 412; Parson's 20/e, p. 251

- Steroid induced cataract is posterior subcapsular which causes the said complaints due to its central position. **Age favours PSC than nuclear cataract**.

46. Ans. (a) Nuclear cataract

Ref: Kanski 7/e, p. 270

47. Ans. (a) Nuclear

Ref: American Academy of Ophthalmology Section 11/p. 77

Occasionally, **nuclear changes** are localized to the inner layers of the lens nucleus, **resulting in multiple refractile areas at the center of the lens**. Such areas may best be seen as irregularities in the red reflex on retinoscopy or direct ophthalmoscopy. This type of cataract can **result in monocular diplopia or polyopia**, including ghost images and occasionally a true second image.

48. Ans. (b) Diabetic cataract

Ref: Basics of vision 1/e, p. 260

- As blood-sugar levels fluctuate, visual acuity and refractive error can change, sometimes dramatically.

49. Ans. (a) Glycated crytallins

Ref: Parson's 21/e, p. 263

- The mechanisms are believed to be **glycation, carbamylation of crystallins** and increased oxidative damage.

50. Ans. (a) Complicated cataract

Ref: Parson's 21/e, p. 262

51. Ans. (d) Complicated cataract

Ref: Parson's 21/e, p. 282

52. Ans. (c) Galactosemia

Ref: Khurana 6/e, p. 193

53. Ans. (a) Ocular trauma

Ref: Parson's 21/e, p. 259

54. Ans. (a) Dislocation of the lens

Ref: Parson's 20/e, p. 252

55. Ans. (b) NADPH+ dependent aldose reductase

Ref: Kanski 7/e, p. 272

56. Ans. (c) Phacolytic glaucoma

Ref: Parson's 20/e, p. 281

Phacomorphic glaucoma occurs in intumescent cataract whereas **Phacotoxic** glaucoma occurs in trauma and **Phacolytic** glaucoma occurs in Morgagnian cataract (Hypermature).

57. Ans. (c) Retinitis pigmentosa

Ref: Parson's 20/e, p. 253

58. Ans. (c) Posterior cortex

Ref: Parson's 22/e, p. 267

Cupuliform cataract is one form of incipient stage of senile cortical cataract. It is a saucer shaped opacity arising from posterior cortex.

59. Ans. (c) Posterior cortex

Ref: Parson's 22/e, p. 268; American Academy of Ophthalmology p. 54

Cataract secondary to intraocular diseases (Inflammatory and degenerative) is called complicated cataract.

They occur due to posterior cortical atrophy.

60. Ans. (b) Galactosemia

Ref: Kanski 7/e, p. 301

Galactosemia – becomes manifest during **infancy** with features of failure to thrive, lethargy, vomiting and diarrhea. Reducing substance is found in urine after drinking milk.

Cataract develops (oil droplet central opacity) within first few days to weeks of life. The exclusion of galactose (milk and milk products) from the diet will prevent the progression of cataract and **may reverse early lens changes**.

61. Ans. (b) Posterior polar cataract

Ref: Khurana 6/e, p. 184

62. Ans. (a) Presence of lens vacuoles

Ref: Parson's 20/e, p. 251, 252

63. Ans. (b) Hypoglycemia

Option a – associated with subluxated lens – ectopia lentis
Option b – Hypoglycemia in utero can cause cataract
Option c – not associated
Option d – Hypocalcemia is associated with cataract (most common in hypoparathyroid children) and not hypercalcemia.

64. Ans. (b) Posterior subcapsular cataract – bladder cells

Ref: American Academy of Ophthalmology, BSCS, Section 11 p. 54, 85, 142

Option a – Elschnig pearls – type of Posterior capsular opacification (PCO), where proliferation of the residual lens epithelial cells occurs on the posterior capsule.
Option b/c – Bladder cells or wedl cells are caused by posterior migration of lens epithelial cells which swell along the posterior capsule giving rise to a posterior subcapsular cataract.
Option d – Soemmering ring – a type of PCO where sequestration of proliferating lens fibers occurs in the equatorial region of the lens capsule.

65. Ans. (b) Incipient cataract

2 cheeky, confusing questions on the change of a word

- **Frequent change of glasses** – cortical (incipient) or nuclear cataract
- **Frequent change of presbyopic glasses** – primary open angle glaucoma.

66. Ans. (b) Galactitol

Ref: American Academy of Ophthalmology, BSCS, Section 11/ p. 61

In Classic Galactosemia (AR) defect in galactose 1-phosphate uridyltransferase (Gal-1-PUT), results in inability to convert galactose to glucose.

↓

Galactose accumulates with further metabolic conversion to galactitol/dulcitol (**responsible for cataract**) and **galactose -1- phosphate (responsible for liver failure)**.

67. Ans. (c) 16 weeks

Ref: Parson's 20/e, p. 257

As foveal fixation develops by 3–4 months of age.

68. Ans. (b) Lameller cataract

Ref: Parson's 21/e, p. 265; Kanski 7/e, p. 298

69. Ans. (a) Blue dot cataract

Ref: Khurana 6/e, p. 185

70. Ans. (c) Zonular cataract

Ref: Parson's 21/e, p. 265; Khurana 6/e, p. 184

- Most common type of congenital cataract → punctate (blue dot) cataract.
- Most common type of cataract which is clinically (visually) significant → zonular or lamellar cataract.

71. Ans. (d) Blue dot

Ref: Parson's 21/e, p. 265; Khurana 6/e, p. 185

72. Ans. (b) Zonular cataract

Ref: Parson's 21/e, p. 265

73. Ans. (a) Immediately

Ref: Duker's Ophthalmology 2/e, p. 420; Parson's 21/e, p. 266, 267

Refer text

74. Ans. (a) ECCE

Ref: Yanoff & Ducker 3/e, p. 450–454

ECCE technique surgeries like conventional ECCE, SICS or phacoemulsification.

75. Ans. (a) CRYGS3

Ref: Yanoff & Ducker 4/e, p. 11

- Most common genes involved in congenital cataract are **crystallin genes:** CRYAA, CRYAB, CRYGC, CRYCD, ***CRYGS.***

76. Ans. (b) Nuclear cataract

Ref: Parson's 21/e, p. 266

- Congenital rubella infection can cause congenital nuclear cataract and congenital total cataract.
- Sometimes it may also cause lamellar (zonular) cataract (Occurs in fetal nucleus. Thus a type of congenital nuclear cataract)

77. Ans. (a) Myopia is common

Ref: Ghai pediatrics, p. 206

Option a – CRS is associated with Micro-ophthalmia, thus causing Hypermetropia due to decreased axial length

Option b – Lamellar cataract is found in CRS. Nuclear cataract is most common.

Option c – Risk to the fetus closely related to the stage of gestation at the time of maternal infection, about 50% during first 8 weeks, 10% between 13 and 24 weeks

Option d – It causes 'non-progressive' salt and pepper fundus.

78. Ans. (d) Postoperative visual acuity is worse in patients with unilateral cataract than bilateral cataract

Ref: American Academy of Ophthalmology, BSCS, Section 11/ p. 46

Option a – Patients with severe bilateral cataract should undergo extraction before fixation develops which is usually **by 3 months** of age

Option b – The posterior capsule is removed (posterior capsular opacification is common in children if left during surgery) together with limited anterior vitrectomy

Option c – Visual prognosis is Poor if nystagmus develops (indicates improper visual fixation)

Option d – Postoperative visual acuity is WORSE in unilateral cataract patients.

79. Ans. (c) Associated with posterior polar cataract

80. Ans. (d) Nd:YAG

Ref: Yanoff 2/e, p. 1559

After cataract or posterior capsular cataract is common after cataract extraction and is reported to occur in 16-50% patients. The most widely used procedure for after cataract is Nd:YAG laser posterior capsulotomy.

Complications of Nd: YAG Laser

- Cystoid macular edema
- Retinal detachment
- Elevated intra ocular pressure
- Late onset endopthalmitis

Contraindications of Nd: YAG Laser

- One eyed individuals
- History of retinal detachment
- Active intraocular inflammation
- Pre existing cystoid macular edema
- Glass intraocular lens

81. Ans. (b) Phacoemulsification

82. Ans. (d) Lens capsule

Ref: Kanski 8/e, p. 293

83. Ans. (b) Phacoemulsification... and (c) ECCE....

Ref: Parson's 20/e, p. 262

- ECCE technique with IOL implantation are the surgery of choice. In ECCE, posterior capsule is left intact

- Phacoemulsification is preferably done with a clear corneal incision but may be done with a small corneoscleral incision also (usually for beginners).

84. Ans. (d) Postoperative topical antibiotics

Ref: Khurana 4/e, p. 197; Yanoff 3/e, p. 435-37; Parson's 20/e, p. 265

"Postop cataract Mx: Antibiotic-steroid eyedrops are used for four times, three times, two times and then once a day for 2 weeks each"

85. Ans. (a) Preferred method of anterior..., (c) Keeps the nucleus..., (d) Resists radial tears, (e) Helps in stabilizing...

Ref: Khurana 6/e, p. 201,203; Parson's 22/e, p. 278-79

CCC resists radial tears
CCC stabilizes the nucleus, allowing maneuvers to disassemble the nucleus within the capsular bag.
CCC also helps stabilize and center the lens implant.

A CCC sized just smaller than the IOL optic may allow a tighter contact between the posterior surface of the posterior chamber IOL and the posterior capsule, possibly ***reducing posterior capsule opacification***.

86. Ans. (c) Potential acuity meter

Ref: Khurana optics 2/e, p. 54

Tests for potential vision
- Laser interferometry (LI)
- Potential acuity meter test (PAM)

87. Ans. (c) Corneal topography

Ref: Yanoff and Duker 4/e, p. 339

88. Ans. (b) Capsular bag

Ref: Ducker's ophthalmology 2/e, p. 473; Parson's 22/e, p. 283

89. Ans. (b) Opacification of posterior capsule

Ref: Cataract surgery by Vajpayee p. 250

"Opacification of the posterior capsule caused by proliferation of cells in capsular bag remains the most frequent complication of ECCE and IOL surgery"

90. Ans. (d) 1064 nm

Ref: Khurana 6/e, p. 461

Wavelength of laser is measured in nm and Nd:YAG Laser is 1064 nm. Nd:YAG Laser is used for posterior capsulotomy and peripheral iridotomy.

91. Ans. (d) Acrylic

Ref: Parson's 22/e, p. 283

Acrylic, Hydrogel, silicon are commonly used materials for foldable IOL.

92. Ans. (a) Antibiotics

Ref: Parson's 22/e, p. 282

Topical antibiotics in the first few weeks after cataract surgery is very important to prevent postop infection. (Endophthalmitis)

93. Ans. (b) A-scan biometry

Ref: Parson's 22/e, p. 143

Normal axial length is 24 mm.

94. Ans. (c) Femtosecond laser

Ref: www.ascrs.com, Recent advances in ophthalmology, HV Nema, section 12/e, p. 13)

95. Ans. (a) ACIOL

Ref: Cornea by Mark J Mannis/p. 196

UGH syndrome is caused by mechanical excoriation of the iris from an IOL haptic or optic that results in uveitis, glaucoma and hyphema.

It is **most commonly due to use of ACIOL**, though it can also be seen with use of PCIOL (if a malpositioned haptic is present).

96. Ans. (a) Cataract extraction

Ref: Khurana 6/e, p. 203

The Blumenthal technique is a manual small incision cataract surgery (SICS) technique devised by Professor Michael Blumenthal from Israel. It is an elegant method utilizing hydrodissection and hydrodynamic expression of the nucleus through a self-sealing scleral tunnel.

97. Ans. (d) Trypan blue

Option a – weak stain for intraocular structures
Option b/c – toxic to corneal endothelium
Option d – non toxic and commercially available

98. Ans. (b) Mechanical > (a) Ultrasonic

Parson's 22/e, p. 280

Phacoemulsification works by to and fro Jack hammer movement.

99. Ans. (b) Homocystinuria

Ref: Parson's 19/e, p. 288, Kanski 7/e, p 306

100. Ans. (a) Superior temporal displacement..., (c) Inferior nasal displacement

Ref: Parson's 22/e, p. 275; Nelson's 20/e, p. 3047, Kanski 8/e, p. 303

Marfan syndrome: Usually superotemporal displacement *(Parson's 22/e, p. 275) and* ***Homocystinuria: Usually inferotemporal displacement*** *(Parson's 22/e, p. 275)*
Confusion: Only parson says inferotemporal all other books (Kanski 8/e, p. 303, Yanoff ocular pathology, 7/e, p. 346, Nelsons 20/e, p. 3047) state that ectopic lentis in Homocystinuria is inferonasal.

101. Ans. (a) Homocys..., (d) Marfan..., (e) Sulphite oxidase...

Ref: Parson's 22/e, p. 275; Kanski 7/e, p. 304-304

102. Ans. (a) Infe... & (b) Lens...

Ref: Parson's 20/e, p. 508, 215, 322; Nelson's 18/e p. 2890

- *Marfan syndrome is the most frequent cause of hereditary ectopia lentis.*

- Marfan syndrome - **upward & outward lens dislocation (up & out)"**
- A forward **dislocation of the lens into the pupil or anterior chamber** may cause pupillary block with acute glaucoma or chronic angle-closure glaucoma.
- Posterior **dislocation** can cause *harmful vitreous traction on the retina with leakage of lens proteins into the vitreous, which may cause chronic vitreitis and chorioretinal inflammation*

Ans. (b) Homocys.. (c) Ehler...& (e) Sulfite...

Ref: Parson's 20/e, p. 506

Ans. (a) Marf..., (b) Homo.. & (e) Sulfite..

Ref: Khurana 4/e, p. 202-03, 3/e, p. 210; Parson's 20/e, p. 506

Ans. (a) Marfan's ..., (c) Homoc.. & (d) Sulphite...

Ref: Khurana 4/e, p. 202-03, 3/e, p. 210

Ans. (c) Superotemporally

Ref: Parson's 20/e, p. 260

Ans. (d) Slit lamp examination

Slit-lamp examination is the choice of method to diagnose a dislocated lens.

Ans. (d) Ectopia lentis

Ref: 'Ophthalmology' by Khurana (2005)/p. 25; 'Clinical Examination in Ophthalmology' by Mukherjee (2006)/166; Neema 6/e, p. 285, 286

Presence of uniocular diplopia together with finding of golden crescent on oblique illumination (edge of subluxated lens) or black crescent line on co-axial illumination (edge of subluxated lens) suggests a diagnosis of 'subluxation' of the crystalline lens.

Ans. (a) 1 CN > (d) 4 CN

Ref: Khurana 5/e, p. 604-05

This injection provides akinesia of the extraocular muscles by blocking cranial *nerves II, III, and VI, thereby preventing movement of the globe. Cranial nerve IV lies outside the muscle cone, but is blocked by diffusion of the local anesthetic.*

Ans. (b) Surface ectoderm

Ref: Yanoff and Ducker 2/e, p. 22-23; Parson's 20/e, p. 5; Khurana 4/e, p. 10

Refer text

Ans. (c) 24 mm

Ref: Physics of human body 22/e, p. 642

Ans. (a) Galactosemia

Ref: Parson's p. 287

Ans. (a) Infrared, (c) UV rays & (d) Obesity

Ref: Parson's 20/e, p. 249; Khurana 4/e, p. 185-86; American Academy of Ophthalmology Section 11/p. 56-57

Microwave radiation has been shown to cause cataracts in laboratory animals. Human case reports and epidemiologic studies are more controversial and less conclusive than experimental studies.

114. Ans. (c) Alport's syndrome

Ref: Kanski 7/e, p. 308

115. Ans. (b) Cataract

Ref: Khurana 4/e, p. 146

If the halos break it is due to cataract and if not it is due to angle closure glaucoma.
Thus, the test is positive in diagnosing cataract. Glaucoma is not being diagnosed by this test. It is a diagnosis by exclusion.

116. Ans. (b) Hallermann-Streiff syndrome

Ref: Kanski 7/e, p. 302

- Spontaneous lens absorption sometimes occurs in older individuals with Hallermann-Streiff syndrome (Salo, Terasaki, Amano, Okamoto & Miyake, 2002)
- **Other ocular features**
  - Microphthalmos
  - B/L, congenital cataract
  - Blue sclera
  - Disc coloboma
  - Nystagmus and strabismus

117. Ans. (d) Cataract

Systemic steroid most commonly cause cataract which is posterior subcapsular cataract whereas **topical steroids** most commonly leads to open angle glaucoma.

118. Ans. (c) B scan

Ref: Parson's 22/e, p. 276

Normally posterior segment examined by ophthalmoscopy, but in mature cataract ophthalmoscopy not possible due to no view. So 'B' scan is used to assess the posterior segment.

119. Ans. (d) Centre of the lens

Ref: Parson's, 22/e, p. 49

- RI of centre of lens – 1.406
- RI of the periphery of lens – 1.386
- RI of cornea – 1.376
- RI of aqueous and vitreous – 1.33
- RI of air – 1

120. Ans. (a) It is associated with hypermetropia

Ref: Kanski 7/e, p. 309

Option a – In micro (small) sphero (spherical shaped) phakia, the lens has increased curvature giving it greater converging power and thus causing myopia.
Option b/c/d – It is associated with Weill-Marchesani syndrome which is an autosomal recessive disorder and has the features of anterior ectopia lentis and short stature with stiff joints.

121. Ans. (b) Tryptophan

Tryptophan-deficiency in the diet leads to an overall significant decrease in kynurenines and levels of antioxidant

enzymes (except SOD) in ocular tissue with a concomitant lenticular opacification. It suggests that diet with adequate tryptophan has protective influence and is of immense benefit in mitigating the changes that may otherwise contribute to the lenticular opacities.

122. Ans. (d) Morgagnian cataract

Option a – In cortical cataract, due to progressive hydration, swelling (increase in AP diameter) of the lens occurs making the anterior chamber shallow.

Option b – Increase in the anterior lens capsule curvature with axial lens thickness due to the action of ciliary muscle on zonules.

Option c – Weill-Marchesani syndrome is associated with Microspherophakia, (small, spherical lens) leading to increase in AP diameter (the equatorial diameter decreases).

Option d – Morgagnian is a type of Hypermature cataract, wherein the cortical material leaks out and is further liquefied, leaving a wrinkled capsule and a Shrunken lens.

123. Ans. (a) Siderosis bulbi > (c) Glaucomflecken

Ref: American Academy of Ophthalmology, BSCS, Section 11/ p. 57-58

Option a – Deposition of iron molecules in the trabecular meshwork, lens epithelium, iris and retina.

Option b - During blunt trauma to eye a circular ring of faint or stippled opacity is seen on the anterior capsule of lens due to brown amorphous granules of pigment lying ᵠ on the capsule.

Option d – Chalcosis occurs when an intraocular copper containing foreign body deposits copper in Descemet's membrane & the anterior lens capsule.

Option c – Glaukomflecken are small, grey-white anterior subcapsular or capsular opacities within the pupillary area which represent focal infarcts of the lens epithelium, almost pathognomonic for past acute-angle closure glaucoma.

124. Ans. (d) Ethambutol

125. Ans. (d) Hypermetropia

Under correction of the refractive power by +2.00 D

↓

Reduced converging power of eye

↓

Image formed behind the retina

↓

Hypermetropia

126. Ans. (d) Opacification of lens

Ref: Kanski 7/e, p. 270; Khurana 6/e, p. 191

Subcapsular cataract (Posterior) – patients are particularly troubled by conditions of miosis such as produced by headlights of oncoming cars and bright sunlight. This is one of the earliest visual disturbances with cataract

127. Ans. (a) Treatment of thickened capsule can be done by discission with cystitome; (b) Treatment by Nd:YAG laser posterior capsulotomy; (d) Posterior capsular opacification (PCO)

Ref: Khurana 6/e, p. 214-215; Parson's 22/e, p. 285

Secondary cataract or Posterior capsular opacification (PCO) occurs following ECCE. It can't occur in ICCE, as lens is removed along with the capsule

Treatment

- Thin membranous – Nd:YAG laser capsulotomy
- Thick (in children) – discussion with cystitome or with Zeigler's knife
- Dense membranous – surgical membranectomy

128. Ans. (c) Canavan syndrome; (d) Reiger syndrome

Ref: Harley's paediatric ophthalmology, p. 262-266

Metabolic abnormalities associated with congenital cataract – Hypoglycemia (bilateral, lamellar cataract is seen), pseudohypoparathyroisim, hypoparathyroidism, hyperglycemia, Galactosemia, fabry disease, lowe syndrome, mannosidosis, Conradi's syndrome, **Zellweger's syndrome (cereberohepatorenal syndrome – zonular cataracts are a consistent finding)**, Cockayne's syndrome

Canavan disease – can cause optic atrophy and Nystagmus. Cataract can be seen in other leukodystrophies such as neonatal onset vanishing white matter disease

129. Ans. (b) Intraoperative Intracameral antibiotics; (c) Use of povidone-iodine solution to paint the lids before surgery (d) Cleaning and sterilization of operation theatre; (e) Postoperative topical antibiotics

Ref: Kanski 7/e, p. 290

Following are likely to be beneficial in **prevention of endophthalmitis**

- Instillation of 5% povidone-iodine into the conjunctival fornices
- Scrupulous preparation of the surgical site and the operation theatre
- Treatment of pre-existing infections
- Prophylactic pre-operative topical antibiotics (fluoroquinolones)
- Intracameral Cefuroxime (1mg in 0.1 ml) injected into AC at the end of surgery
- Early resuturing of any leaking wounds

130. Ans. (b) Sulfatase deficiency

(Ref: Kanski 7/e, p. 304)

131. Ans. (d) Myotonic dystrophy

Ref: Parson's 22/e, p. 269

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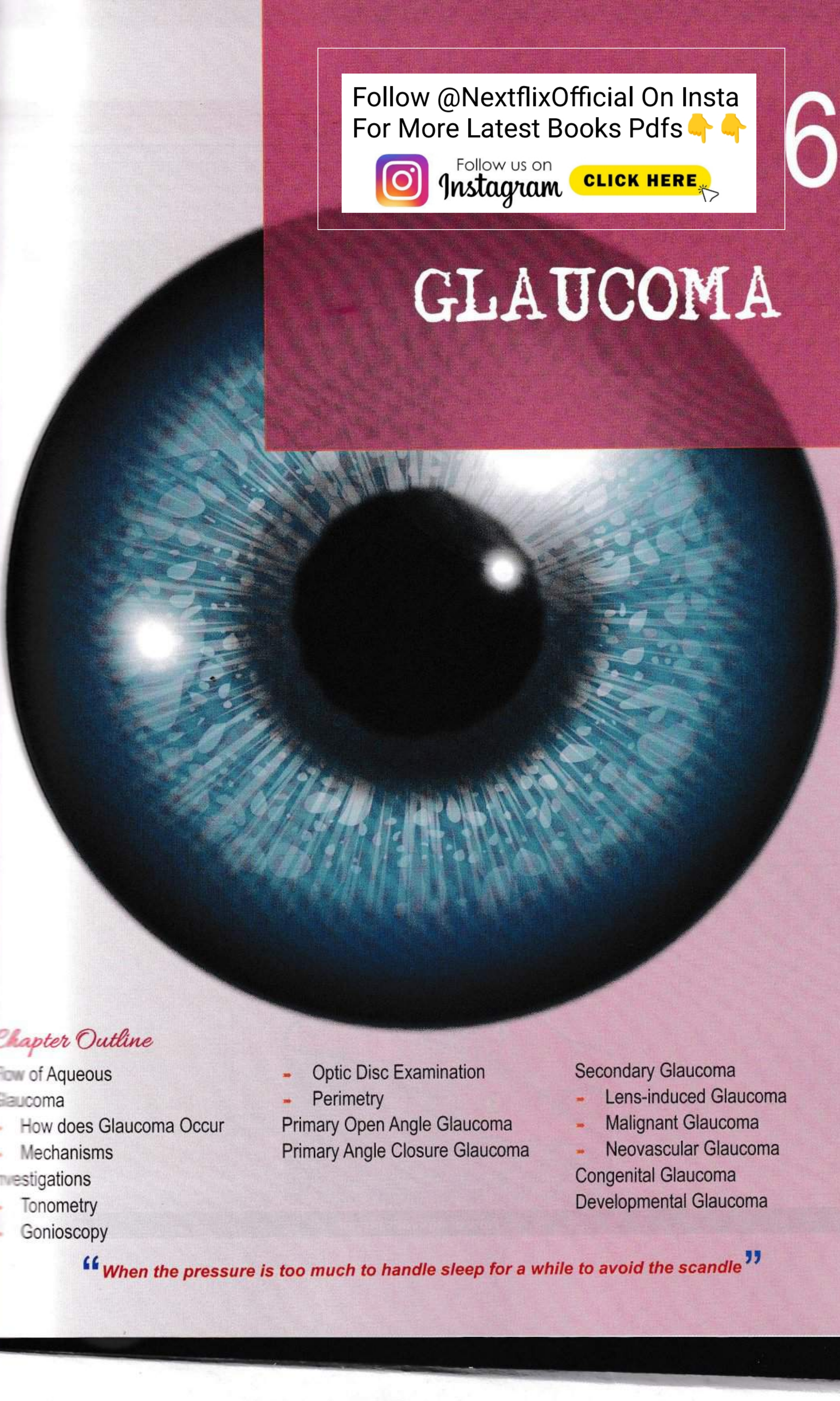
6 GLAUCOMA



Chapter Outline

Flow of Aqueous

Glaucoma
- How does Glaucoma Occur
- Mechanisms

Investigations
- Tonometry
- Gonioscopy
- Optic Disc Examination
- Perimetry

Primary Open Angle Glaucoma

Primary Angle Closure Glaucoma

Secondary Glaucoma
- Lens-induced Glaucoma
- Malignant Glaucoma
- Neovascular Glaucoma

Congenital Glaucoma

Developmental Glaucoma

"When the pressure is too much to handle sleep for a while to avoid the scandle"

FLOW OF AQUEOUS

Secretion (1)
Non-pigmented epithelium[Q] of pars plicata (Ciliary body)
Functional unit – Ciliary processes

↓

Posterior chamber (PC) (2)

↓

Via pupil

↓

Anterior chamber (AC) (3)

↓

Angle of anterior chamber (Iridocorneal angle)

↓

Outflow

↓

Trabecular (Conventional) (4)
Intraocular pressure (IOP) sensitive route
70-95%[Q] – increases with age

↓

Trabecular Meshwork (TM)
Uveoscleral: The innermost part (25–75 μm)
Corneoscleral: Middle part (50 μm)
Juxtacanalicular: The outermost (2–20 μm)

↓

SCHLEMN'S canal
Inner wall endothelium contains vacuoles which open in response to pressure (IOP) to transport aqueous.

↓

Aqueous Vein

Intrascleral Plexus

↓

Episcleral Vein

↓

Drains into cavernous sinus via anterior ciliary vein and superior ophthalmic vein

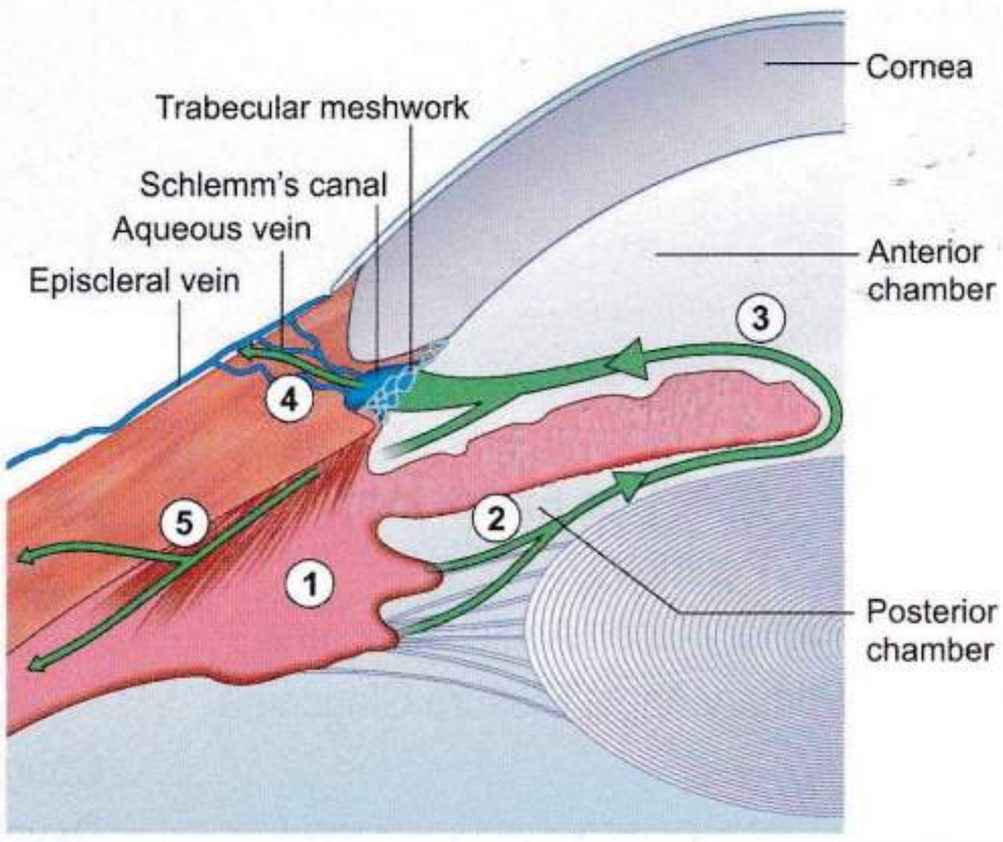
(5) Uveoscleral (Nonconventional)
Intraocular pressure independent route
30% to 5%[Q] – decreases with age

↓

Suprachoroidal Space[Q]
Space between ciliary body and sclera

EXTRA MILE

- Aqueous formation starts at 4 to 6 months of gestational age
- Aqueous formation
  - **70% – Active secretion** (Na^+ K^+ ATPase and Cl^- channels)
  - 20% – Ultrafiltration
  - 10% – Osmosis
- Aqueous secretion is
  - Increased by adrenaline, α_2 receptor stimulation
  - Decreased by acetylcholine, β_2 receptor stimulation



Flow of Aqueous humor

High Yield

- Uveo-Vortex flow: Transfer of fluid into iris vessels and vortex veins. It is clinically relevant in nanophthalmic eyes
- Normal Episcleral venous pressure is 8–11 mm Hg
- **Tonography:** [Q]Used to determine the facility of aqueous outflow (C-value)
  - C-value = $\frac{\text{Flow rate}}{\text{IOP (–) Episcleral venous pressure}}$
  - Normal C-value = 0.25 µL/min/mm Hg
- Juxtacanalicular trabecular[Q] meshwork (Type III collagen) and inner endothelium of Schlemm's canal offer maximum **resistance to aqueous outflow[Q]**.

GLAUCOMA

A group of disorders characterized by ***chronic*, progressive** optic neuropathy resulting in

- Characteristic **optic disc** change (due to **retinal ganglion cell[Q] death**)
- Irreversible, progressive **visual field changes**
- Associated frequently but **not always** with **raised IOP** (Raised IOP is a Risk Factor)

HOW DOES GLAUCOMA OCCUR?

Pathophysiology

Glaucoma occurs essentially due to either

(IOP) Pressure Related events
(Mechanical theory)

↓

Structural changes such as alterations in extracellular matrix of Trabecular meshwork or endothelial cells & scar, debris over angle structures

↓

Functional changes such as obstruction to aqueous outflow

↓

Increase in IOP

↓

Narrowing of openings in Lamina cribrosa

↓

Reduced axoplasmic flow

↓

Glaucomatous optic atrophy and visual field defects

(IOP) Pressure Independent events
(Ischemic theory)

↓

Structural changes in vessels supplying the optic nerve

↓

Decreased optic nerve head perfusion

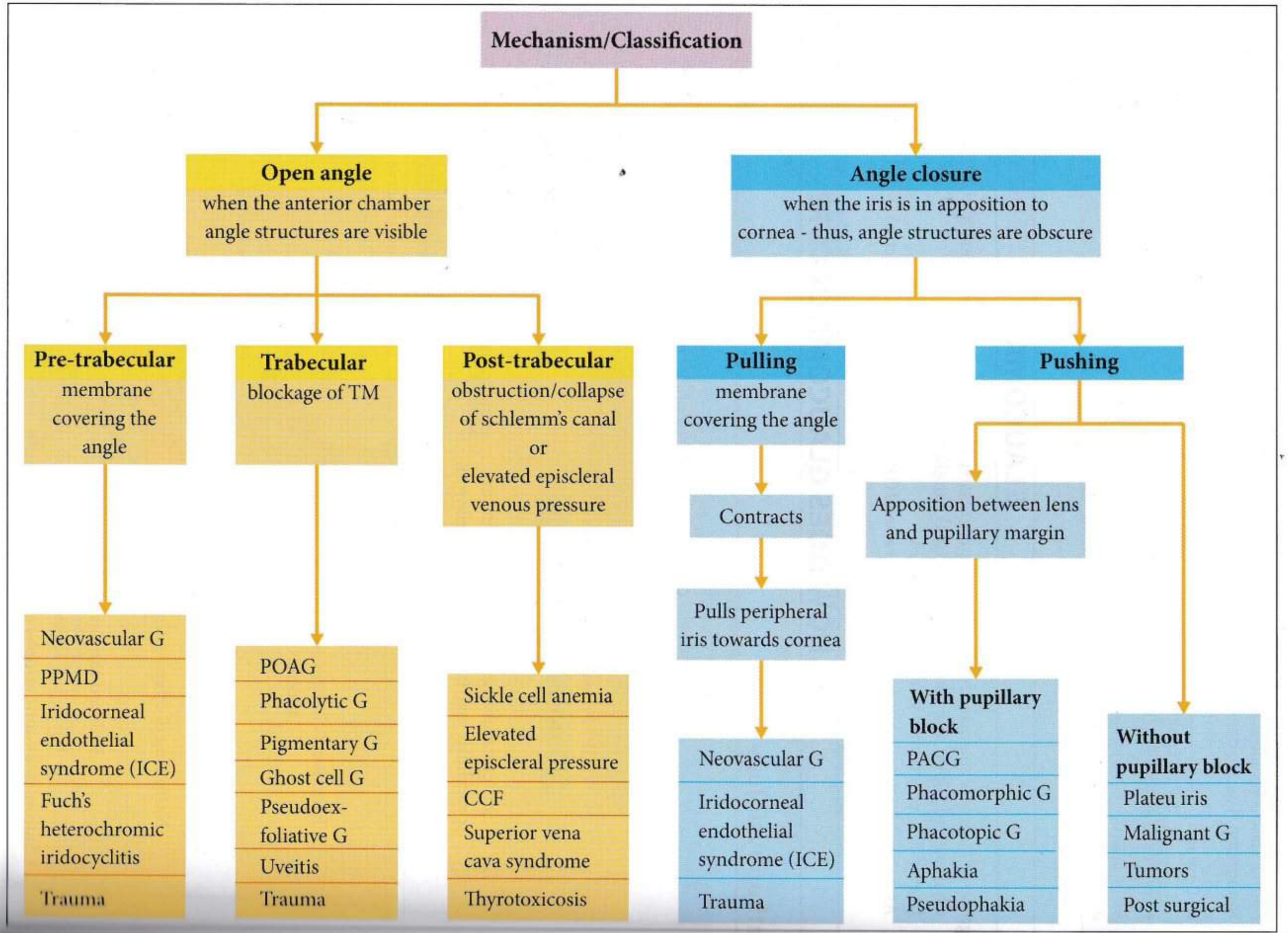
↓

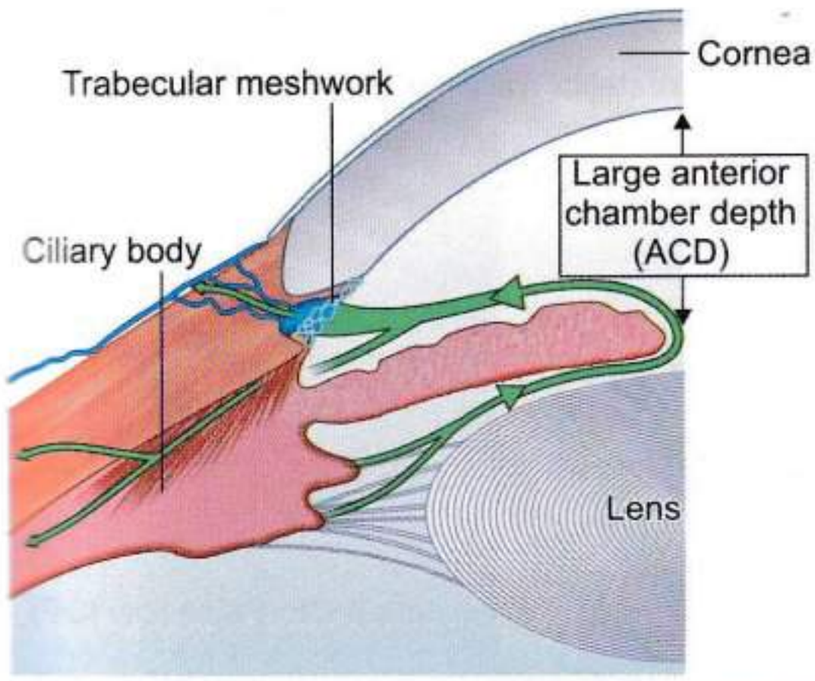
Glaucomatous optic atrophy and visual field defects

Neurotrophin deprivation (BDNF – Brain derived neurotrophic factor) contributes to Retinal ganglion cell death.

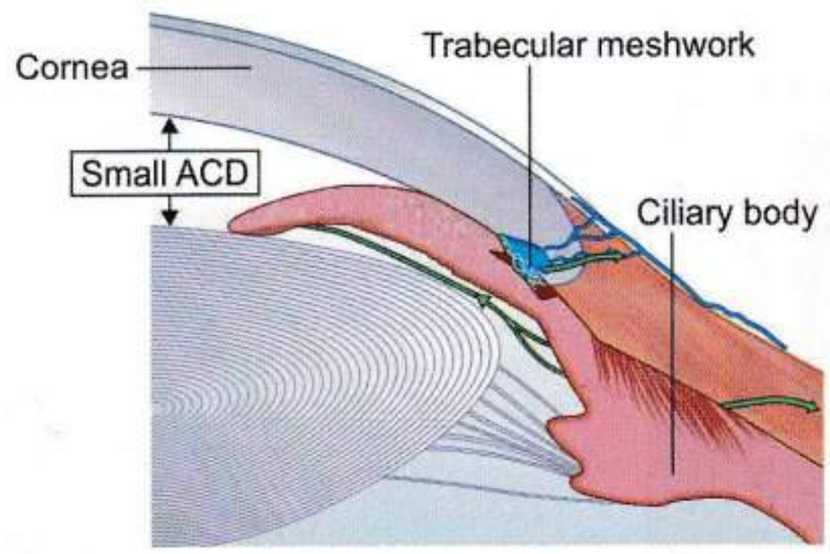
Mechanism/Classification

Based on our current conceptual understanding, the cause of glaucoma, identifiably, essentially is **obstruction to aqueous outflow**, which can be due to the following:





Open angle glaucoma



Angle closure glaucoma

INVESTIGATIONS – GLAUCOMA

- Optic disc examination
- Visual field examination
- IOP measurement
- Examination of angle of anterior chamber

IOP Measurement: Tonometry

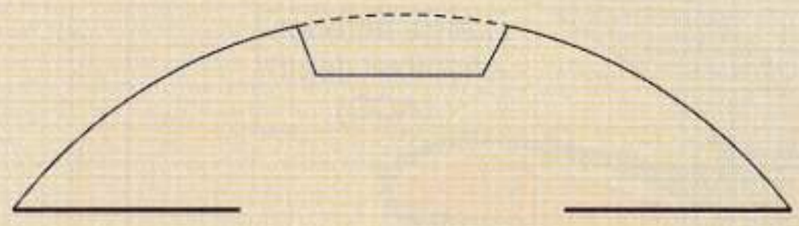
- Normal IOP: 11–21 mm Hg
- IOP has a diurnal variation, with **IOP being maximum during morning 8 am to 12 noon** (Late morning). Normal eyes may have a diurnal variation of 5 mm Hg
- Factors affecting IOP

Increased by	Decreased by
• Age • Smoking • Myopia (increased axial length) • Valsalva maneuver • Muscle relaxant (suxamethonium) • Herpetic uveitis • Posner-Schlossman syndrome	• Cold air exposure • Aerobic exercise • Rhegmatogenous Retinal detachment • General anesthetics **except** Ketamine and succinylcholine • Metabolic acidosis

Types of Tonometry

Name	Description
Digital Tonometry 	• Palpation of eyes (soft touch – low IOP, Firm touch – normal IOP, Hard touch – high IOP) • Gold standard in patients **with keratoprosthesis**
Indentation Tonometry	

Contd...

Name	Description
• **Schiøtz[Q] Tonometer** 	• High displacement (of aqueous) tonometry, creates a Truncated Cone corneal deformation  • Always done in supine position • Uses **Friedenwald's Nomogram** conversion tables, which factor ocular rigidity (OR): IOP variation is directly proportional to ocular rigidity

Increased OR (False high IOP)	Decreased OR (False low IOP)
• **H**ypermetropia	• **M**yopia
• **L**ong-standing glaucoma	• With increasing **a**ge
• **A**ge related macular degeneration (ARMD)	• Miotics - **P**ilocarpine

• **Rebound Tonometer**	• **Choice[Q] for Self/Home tonometry**, and can be used **without anesthetizing** the eye
Applanation Tonometry **Fixed force**: Maklakov, Tonomat, Barraquer **Fixed Area**: Goldmann's[Q], Perkin's, Pneumatic, Draeger, Mackay marg, Tono-pen, Pascal	• Based on **Imbert-Fick principle**, P = F/A (IOP is equal to force applied/area of cornea applanated) • Shape of deformation produced is simple flattening • Not affected by ocular rigidity
• **GOLDMANN'S Pascal Tonometer (GAT)** 	• **GOLD[Q]** standard tonometry. It is a slit lamp mounted instrument • Fixed area = 3.06 mm diameter • Procedure: Cornea anesthetized (Topical) ↓ Stain cornea with 0.25% **Sodium fluorescein[Q]** dye ↓ Biprism illuminated by **COBALT blue light** brought into gentle contact with cornea ↓ Biprism splits the circle of contact into 2 semicircles (**mires**) ↓ Force adjusted until the **inner edges of mires just touch each other** and IOP calculated by multiplying dial reading with 10

Contd...

Name	Description
Applanation Mires 0.25–0.3 mm, inner edges just touching each other – correct end point	• Sources of error in GAT **False low IOP** • Thin cornea[Q] (post LASIK) • Less fluorescein (narrower meniscus) • With the rule astigmatism (3D = 1 mm Hg IOP decrease) • **Corneal edema** – Thick cornea with False low IOP, due to softer, more indentable cornea **False high IOP** • Thick cornea • Too much fluorescein (wider meniscus) • Against the rule astigmatism (3D = 1 mm Hg IOP increase) • Elevating eyes > 15° • Widening of lid fissure
• **Perkins tonometer** 	• Handheld/portable applanation (fixed area) tonometer • **Used for** ▪ Children ▪ Bed-ridden patients ▪ In operation theatres (for patients under anaesthesia) • Consists of the same biprisms as GAT
• **Mackay-Marg Tonometer**	• It uses a plunger for flattening of cornea (Fixed area = 6 mm) and the value of IOP is electronically recorded • **Choice[Q] in irregular, scarred, edematous[Q]** corneas and when measuring IOP through soft contact lens
• **Tono-pen**	• Mixed indentation and applanation mechanism • Can be used over bandage contact lens • Also useful in camps (as handheld and uses disposable covers)
• **Pneumo Tonometer/Pneumatic Tonometer** 	• Cornea is flattened by a jet of air within a small chamber • **Useful for** ▪ irregular and edematous cornea ▪ through soft contact lens ▪ for **continuous IOP** measurement
• **Pascal Tonometer (Dynamic contour testing)**	• **Less influenced by changes in corneal thickness** and ocular rigidity • More influenced by changes in corneal curvature • It also measures Ocular Pulse Amplitude (difference between maximum and minimum IOP) which may be an indicator of status of ocular blood flow • **Choice following refractive surgeries (LASIK)**

Contd...

Name	Description
Non contact Tonometry	
• **Grolman's Tonometer/Pulsair/ Air puff Tonometer**	• Applanation by a jet of air → reflected light measured by a photoelectric cell • **Choice for Screening**
• **Reichert Ocular Response analyzer (ORA)**	• Jet of air **measures Corneal Hysteresis**, i.e. the ability of cornea to absorb and dissipate energy, an indicator of corneal biomechanical properties
• **Corvis**	
Transpalpebral Tonometry	Can be used for Self/Home tonometry
• **Proview**	• Pressure Phosphene tonometer, **based on entoptic phenomenon**
• **Diaton** 	• Usually used through upper eyelid • Based on rebound phenomenon

Pachymetry

- Central Corneal thickness (CCT) measurements need to be done before measurement of IOP, as IOP measurement depends/directly varies with CCT.
- Thicker CCT – False high IOP – True IOP will be lower than measured
- Thinner CCT – False low IOP – True IOP will be higher than measured

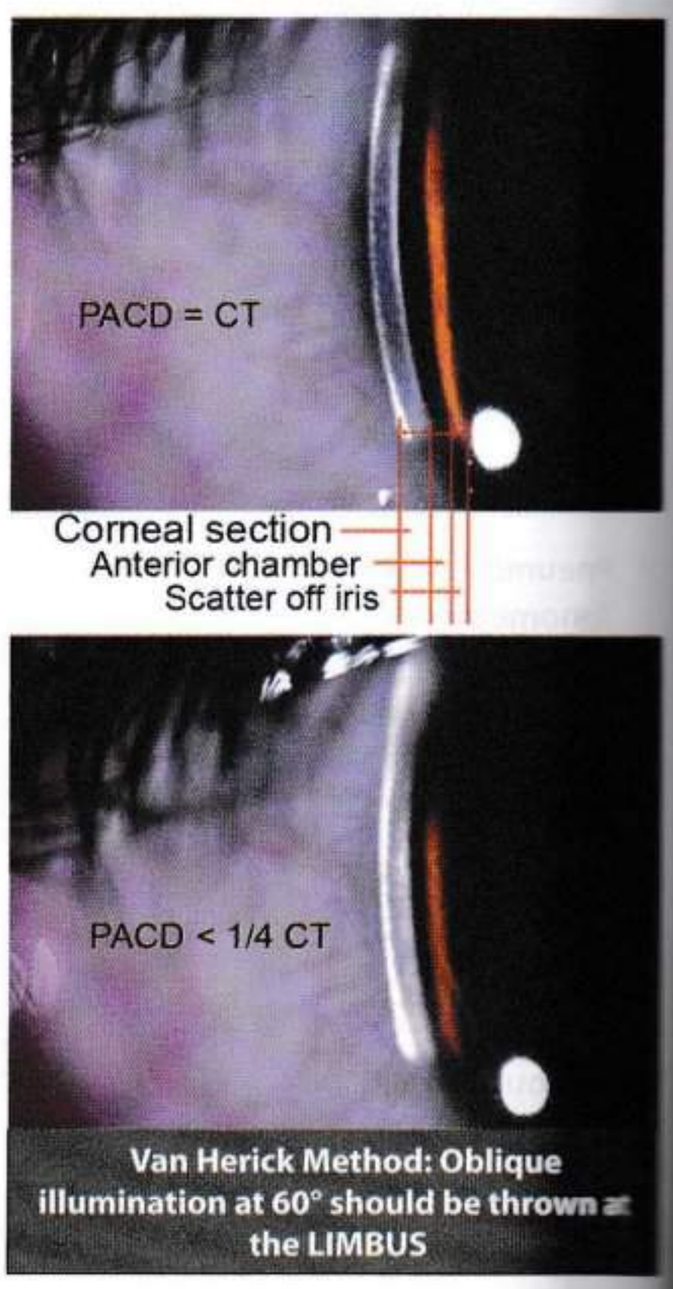
Examination of Angle of Anterior Chamber

Done to classify glaucoma as open angle or closed angle

Van Herick's Method[Q]

Estimates Anterior chamber angle width as a ratio of peripheral anterior chamber depth **(PACD) to corneal thickness (CT)**

PACD/CT	GRADE	
≥ 1	4	Wide open angle
< ½ - >1/4	3[Q]	Open angle - incapable of closure
¼	2	Moderately Narrow - should be gonioscoped
<1/4	1	Very NARROW angle (potentially occludable)



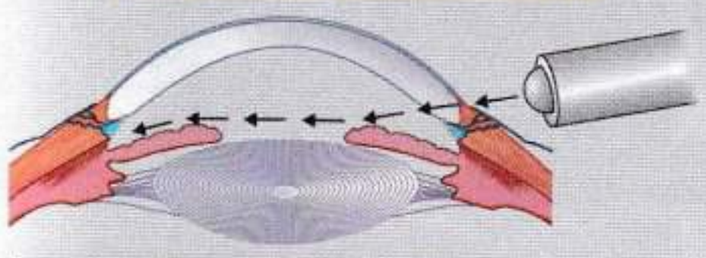
Van Herick Method: Oblique illumination at 60° should be thrown at the LIMBUS

Oblique Flashlight Test

Light is thrown on the eye **from the temporal side** by a penlight

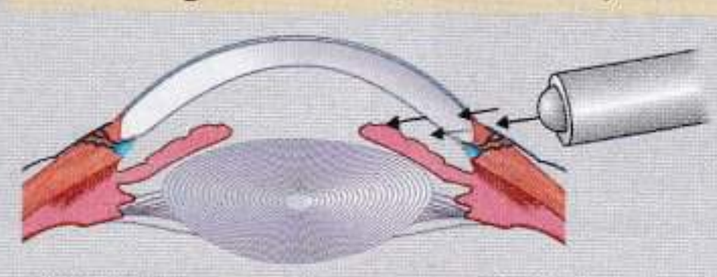
Iris illuminated on both temporal and nasal side **(No Shadow)**

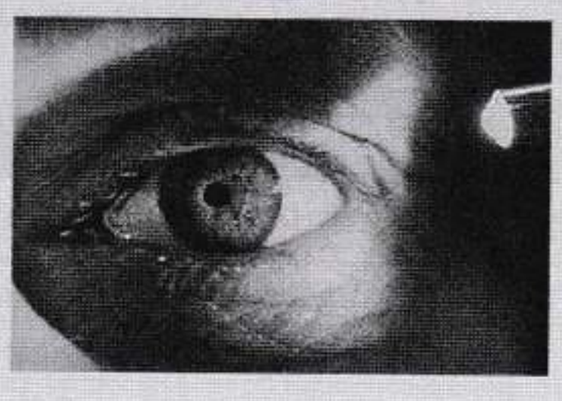
Angle is Open (Deep AC)



Iris illuminated only on temporal side, with **Shadow on Nasal side** (due to iris bowing forward), known as **Eclipse Sign**Q

Angle Closure (Shallow AC)





Gonioscopy

Principle

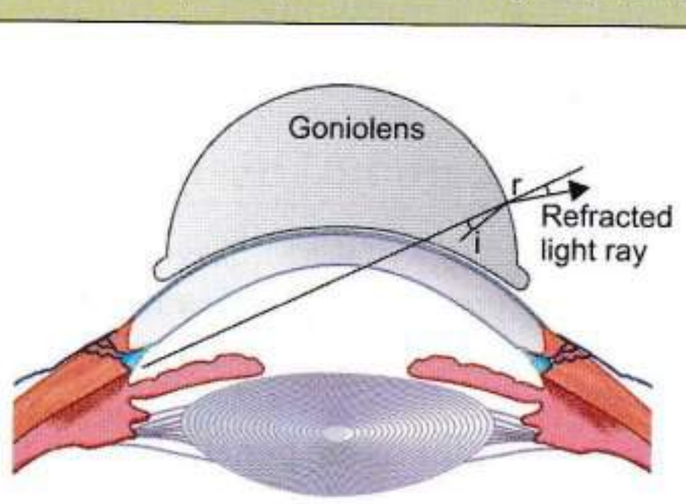
Elimination of Total Internal reflectionQ

The principle of total internal reflection is also used in fiberoptic cables and applanation tonometer

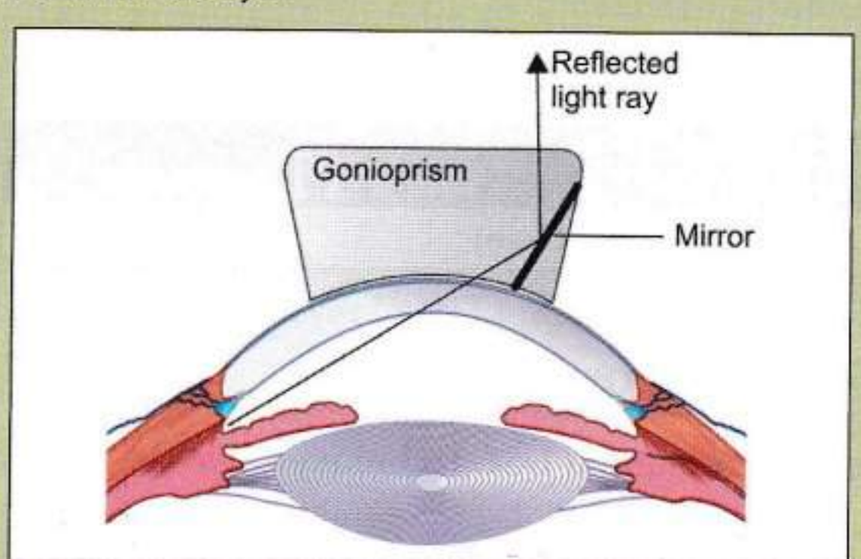
EXTRA MILE

In eyes, normally, light rays coming from the AC fall on the cornea at an angle **greater than 46° (CRITICAL ANGLE)**Q and are thus, reflected back into the chamber.

In indirect or direct gonioscopy, lenses are placed over the cornea, which have a refractive index similar to cornea, and thus light enters the lens and is then refracted (Direct) or reflected by a mirror (Indirect) outside the eye.



Direct gonioscope



Indirect gonioscope

Types of Gonioscopy

DIRECT Gonioscopy (GONIOLENS)	INDIRECT Gonioscopy (GONIOPRISM)	
Done in **supine** position	Done in **sitting** position on slit Lamp	
• Koeppe • Barkan • Swan – Jacob Used in sedated, anesthetized, OT patients and **infants**	• **Indentation** ▪ Zeiss four mirror ▪ Posner four mirror Can **distinguish between** Appositional (reversible) and Synechial (permanent) closure	• **Nonindentation** ▪ Goldmann single mirror (62° mirror) ▪ Goldmann Three mirror (3 mirrors at 59°, 67°, 73°) – Can also be used for Laser Trabeculoplasty

Koeppe lens

Four mirror gonioscope

Structures visible in the Angle on Gonioscopy

Posterior ↓ Anterior

Mnemonic

Angle structures (Posterior to Anterior)

Can't	Ciliary body band	Part of ciliary body visible between iris and Trabecular meshwork
See	Scleral spur	Most anterior projection of sclera, internally
This	Trabecular meshwork	Anterior non-pigmented Posterior pigmented (functional part)
Stuff	Schwalbe line[Q]	Represents the peripheral termination of Descemet membrane of cornea, (identified by 'Corneal Wedge')

Classification Systems for Grading Gonioscopic Findings

Scheie		Shaffer	Spaeth
Based on visible angle structure (s)		Based on Angular width	Based on • Angular width • Configuration of peripheral iris • Iris root insertion
	Grade		
All structures visible (WIDE OPEN)	**I**	< 10°	
Ciliary body band obscured	**II**	10–20°	
Ciliary body band, Scleral spur and posterior Trabecular meshwork obscured	**III**	25°–35°	
Only schwalbe line visible (closed)	**IV**	35°–45° (WIDE OPEN)	

Mnemonic

1 2 Ka 4 (open to close) 4 2 Ka 1

S

O

C

H

Ultrasonic Biomicroscopy (UBM)

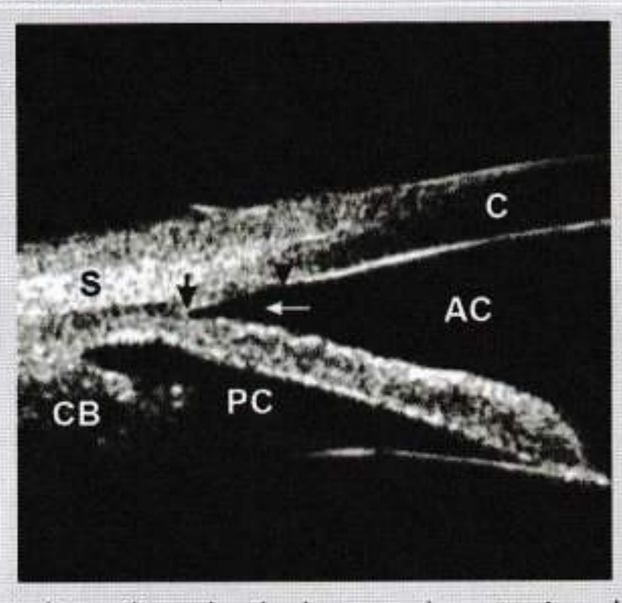
Non-invasive, high resolution USG technique, 50 MHz frequency waves are used for tissue penetration up to 4 mm

Anterior Segment – ASOCT

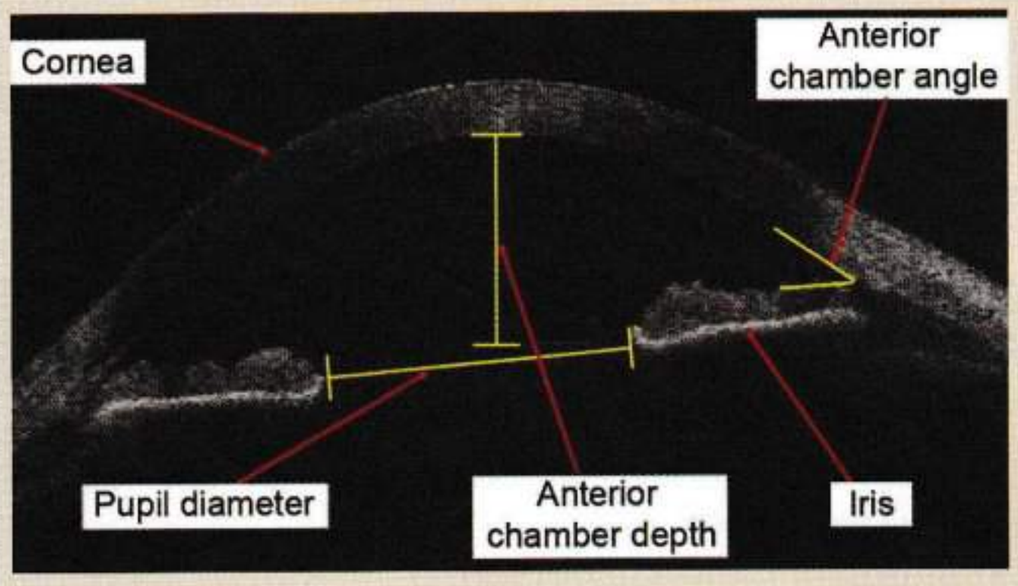
Non-contact, non-invasive method of CT scan using 1310 nm wavelength for higher resolution

EXTRA MILE

Ultrasonic Biomicroscopy	Anterior Segment – Optical Coherence Tomography
Contact – needs a water bath coupling media	Non contact
Based on sound waves	Based on light waves
Can be used to visualize anterior segment through opaque media	Used only in clear cornea
Can visualize structures posterior to iris pigment epithelium	Cannot visualize posterior to iris pigment epithelium
Patient in supine position	Patient seated upright
Lower resolution, slower acquisition time	Higher resolution, faster acquisition time



(Can visualize ciliary body, lens and posterior chamber)

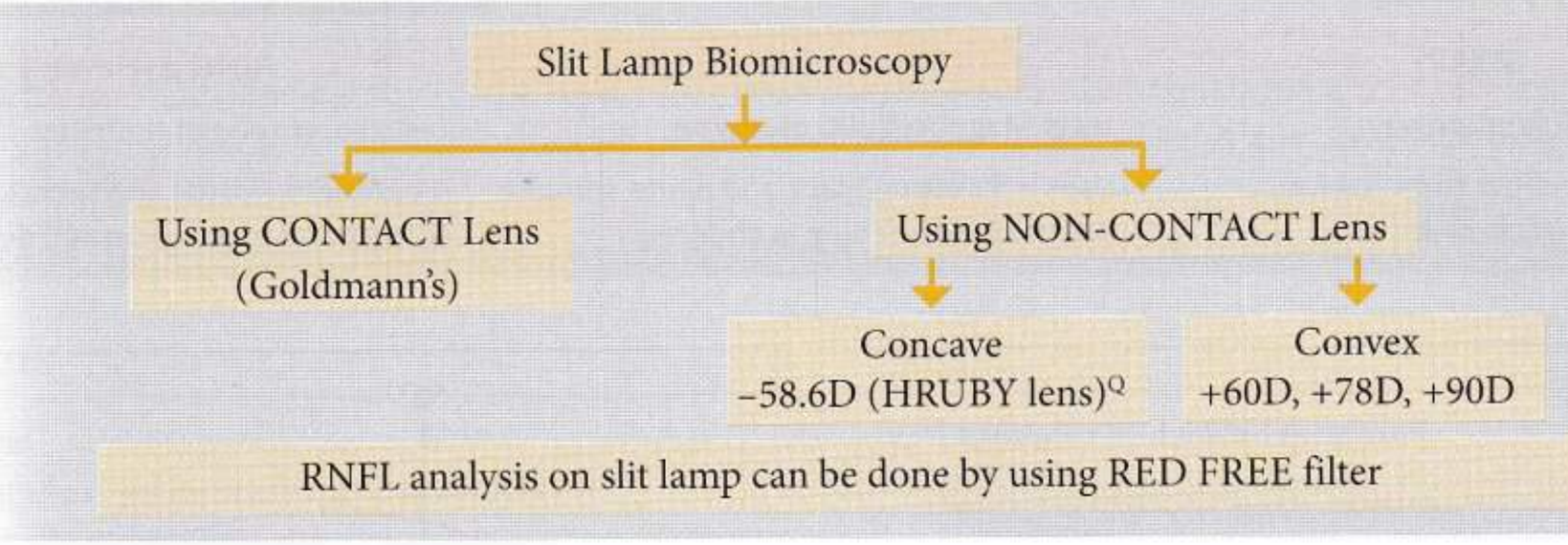


Examination of the Optic Disc

Direct Ophthalmoscopy

Handheld instrument used to visualize the optic disc and macula (Details in chapter 8 Retina)

Slit Lamp Biomicroscopy



Confocal Scanning Laser Tomography (CSLO)

- Heidelberg retina tomograph (HRT) – uses 675 nm **diode** laser as a light source
- Used to study optic nerve head (ONH) morphology and retinal nerve fiber layer (RNFL) thickness.

Spectral Domain OCT

for analysis.

Confocal Scanning Laser Polarimetry (SLP)

- Used to measure RNFL thickness using polarized diode laser (780 nm)
- GDx PRO is the current name of the instrument.

Visual Field examination – Perimetry

Kinetic

Moving stimulus from non-seeing to seeing area

Point of perception recorded

All points are joined together to from an isopter (2D plot)

E.g. Goldmann perimeter, bjerrum tangent screen

Static

Presentation of stationary object with varying intesity

Suprathreshold

Used for screening

Threshold

Most commonly used for monitoring glaucomatous fields

E.g automated perimeters such as Humphrey field analyzer (HFA), Dicon, octopus

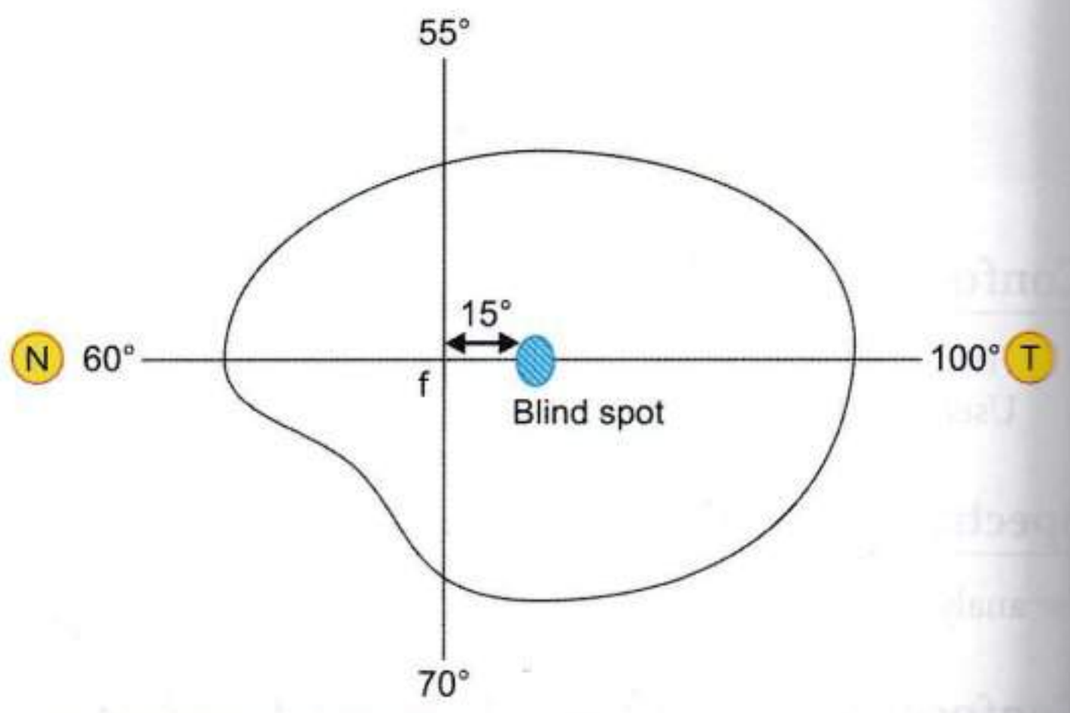
EXTRA MILE

Humphrey field analyzer (HFA)

- Uses static white on white stimuli standard automated perimetry (SAP)
- Bowl type screen
- Target size - Goldmann III - 4 mm^2
- Background luminance-31.5 asb
- **Testing pattern** → 24–2 or 30–2, i.e. central 24°/54 point grid or 30°/76 point grid tested with a 6° separation between 2 test locations.
- Grey scale printout test result – clover leaf shape indicates false negative result
- **Testing strategies**
  - Suprathereshold
  - Full threshold - uses 'Staircasing' effect
  - SITA (Swedish Interactive Threshold algorithm) – Most commonly used
  - Fastpac
  - TOP-Tendency oriented perimetry – for OCTOPUS
- **Newer perimetry strategies**

HFA

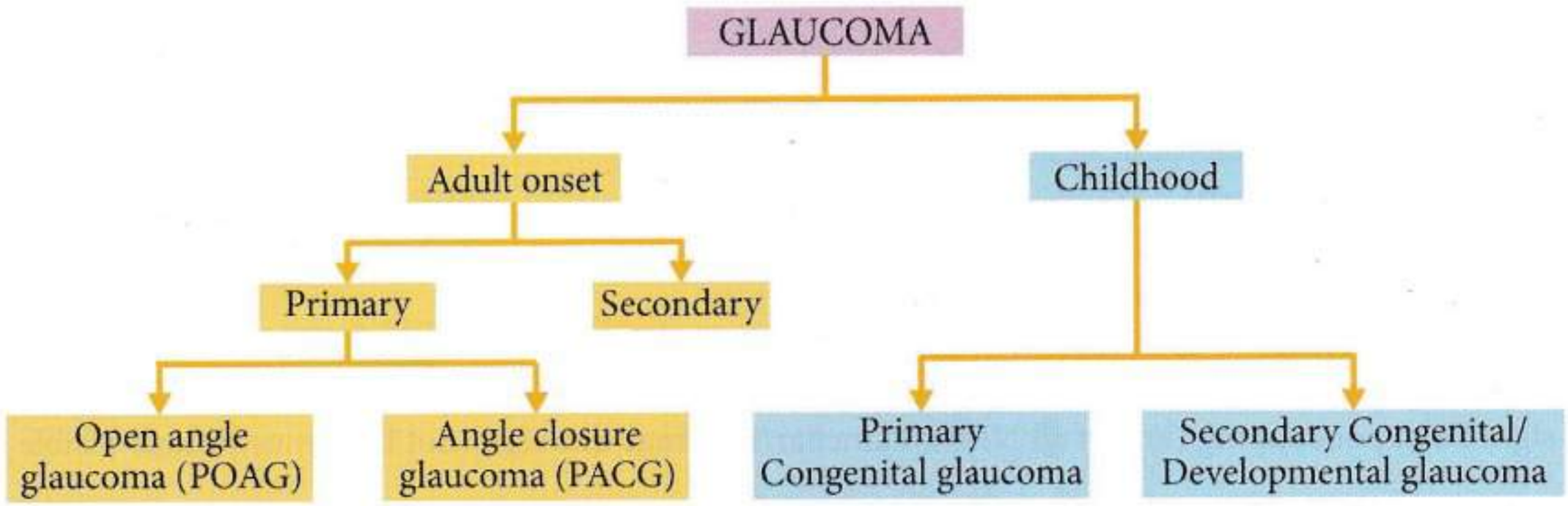
SWAP[Q]	FDT	RING perimetry
Tests Koniocellular pathway	Tests Magnocellular pathway	Tests Parvocellular pathway
Uses **blue on yellow stimulus** for Bistratified ganglion cells	Uses a flickering black and white stimulus (25 Hz) for screening in children	A peripheral visual acuity test. Results correspond to ganglion cell density



- Visual field is horizontal oval with inferonasal depression/notch
- Visual field is opposite to retina
- Blind spot in Temporal field as OD in Nasal half of retina

Normal visual Field

TYPES OF GLAUCOMA



PRIMARY OPEN ANGLE GLAUCOMA (POAG)

- It is also known as **chronic** open angle glaucoma (COAG) or **simple** chronic glaucoma
- Usually bilateral, symmetrical, with an **adult onset** (age > 40 years)[Q] and no sex predilection

Mechanism

Inherent defect/abnormality of the trabecular meshwork
(May be due to aqueous outflow pump failure or an immunogenic mechanism)

↓

Aqueous outflow obstruction

Risk Factors

Ocular Hypertension Treatment study (OHTS) said that **risk** for conversion from ocular hypertension (IOP > 21 mm Hg with normal disc and visual fields) to POAG is **directly proportional** to Age, IOP, c/d ratio and **inversely proportional** to central corneal thickness (↑CCT-↓risk of POAG)

Myopia, Diabetes, Hypertension, Family history were **not found** out to be significant risk factors

Symptoms

a. Headache
b. Frequent changes in presbyopic spectacles[Q]

Frequent changes in Myopic spectacles indicates Cataract

c. Difficulty in dark adaptation[Q]

Visual Acuity is NORMAL in patients of POAG

Signs

IOP

- >21 mm Hg
- > 8 mm Hg diurnal variation
- > 5 mm Hg difference (asymmetry) between the two eyes

Increased IOP with no optic disc change & no visual field defect is known as **ocular hypertension**
Normal IOP with optic disc and visual field changes is Normal Tension Glaucoma (**NTG**)

NTG is commonly associated with Raynaud phenomenon, migraine and reduced blood flow velocity in ophthalmic artery

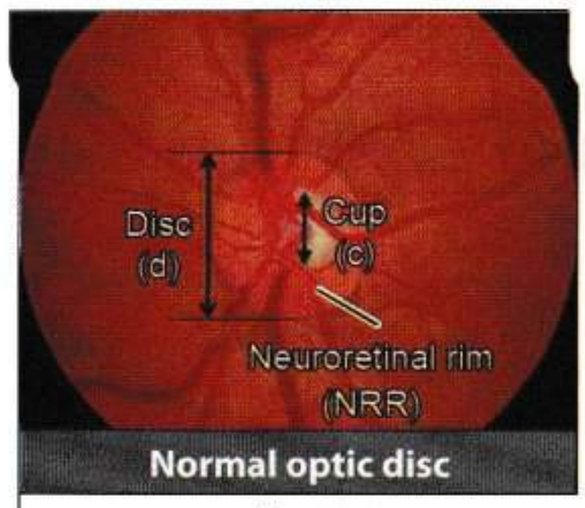
Pupils

- Normal shape, sluggish reaction
- RAPD (Marcus Gunn pupil) is an indicator of advanced disease

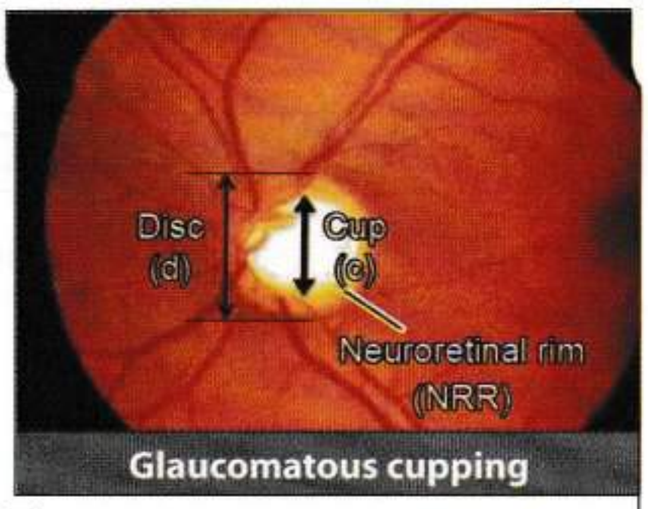
Optic Nerve Head (ONH) Changes

- **Loss of Neuroretinal rim (NRR)** – Hoyt's sign
  - Early sign: Loss of inferotemporal rim (polar notching)
  - Late sign: Loss of Nasal NRR, Sharpened edge or rim
- **Cupping** - loss of NRR leads to enlargement of the cup
  - Early sign: **Vertical[Q] c/d ratio > 0.5**, or asymmetry of c/d ratio > 0.2 (Normal c/d ratio = 0.3 – 0.4)[Q] between the two eyes
  - Late sign: Bean pot cupping (loss of all NRR), Lamellar/**Laminar dot sign** (dot like fenestrations-visible grayish hue)

Polar notching

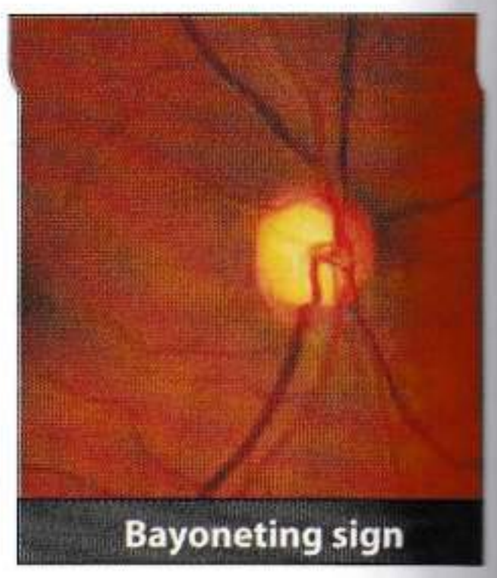


Normal optic disc



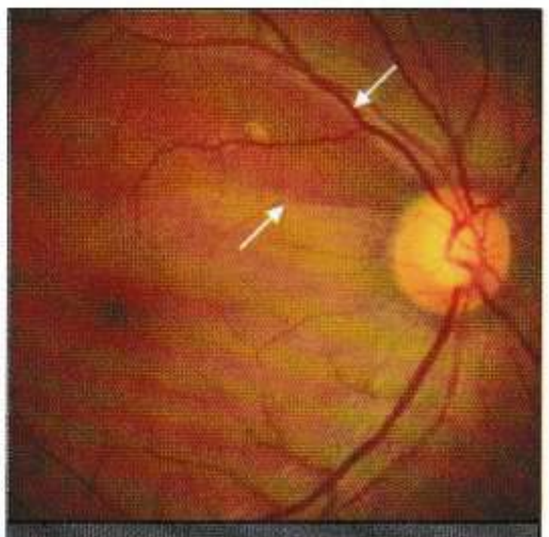
Glaucomatous cupping

c/d ratio is a measure of Glaucomatous progression

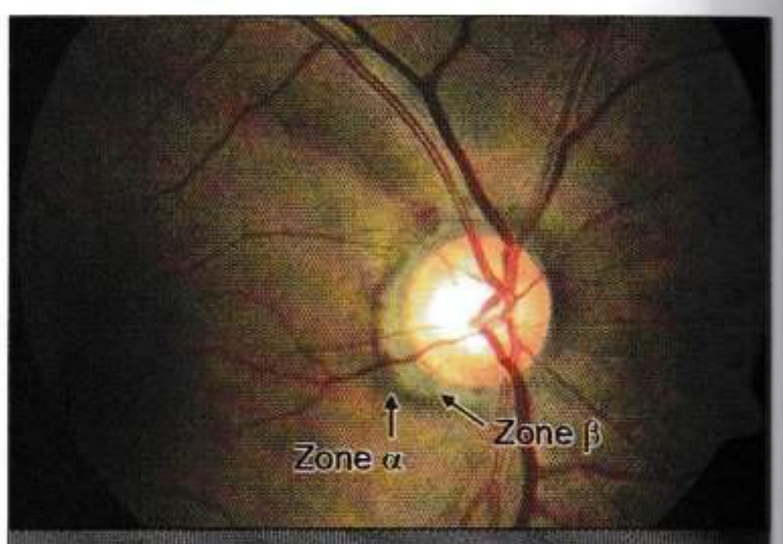


Bayoneting sign

- **Vessel changes**
  - Early sign: Splinter disc hemorrhages[Q], baring of circumlinear vessels, overpass cupping
  - Late sign: **Bayoneting sign[Q]** – Double angulation of a blood vessel due to sharp bend at the edge of a disc and then again to run across Lamina cribrosa
  - Pulsation of retinal arterioles
- **RNFL wedge shaped[Q] defects:** Most useful parameter for early detection of glaucomatous optic disc damage
- **Peripapillary atrophy:**[Q] atrophy around (peri) the optic disc (papillary)



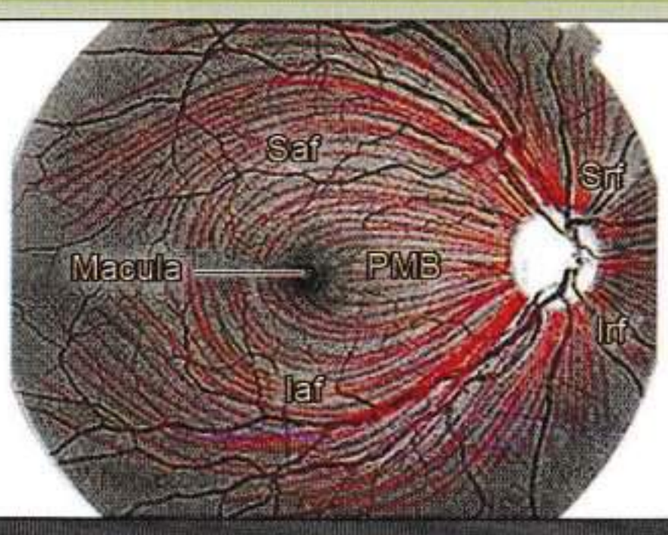
RNFL wedge shaped defect



Peripapillary atrophy

Zone α (Outer) darker, Zone β (Inner) lighter

Extra Mile



Arrangement of nerve fibers in RETINA

Srf, Irf-superior and inferior radiating fibers (from nasal half of retina)
PMB-papillomacular bundle (horizontally from macula)
Saf, Iaf-superior and inferior arcuate fibers (arches from temporal half of retina)

- Macular fibers are most resistant (Pmb)
- Arcuate fibers are most sensitive to glaucomatous damage and constitute the BJERRUM area (saf, iaf)
- Nerve fiber loss occurs before[Q] reproducible visual field defects.

Visual Field Defects

Baring of the blind spot ← Isopter contraction (earliest defect)^{Q} ← Variability in responses from areas that subsequently develop defects

Generalized central depression

PARACENTRAL scotoma

↓

Connects with blind spot

SEIDEL'S scotoma (comma shaped)

↓

Enlarges & arches above/below the fixation point, to the horizontal median saphe-corresponding to arcuate fibers

BJERRUM / ARCUATE scotoma

↓

RING / DOUBLE ARCUATE scotoma

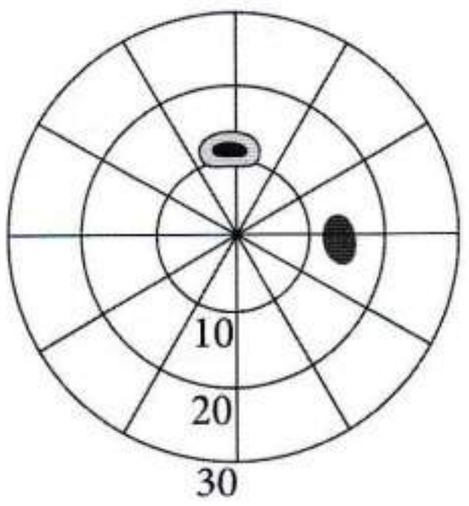
↓

Roenne's central or peripherial NASAL STEP

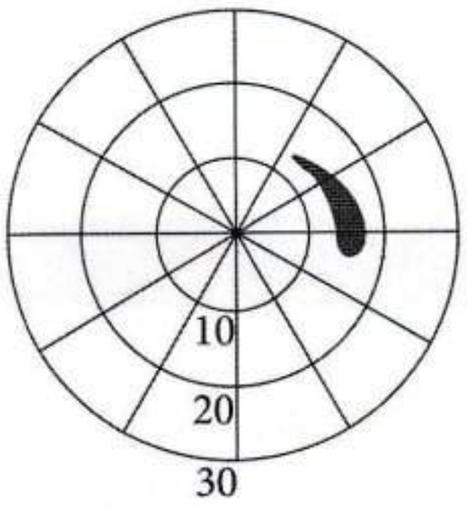
(due to loss of nerve fibres at different rates in upper and lower parts)

↓

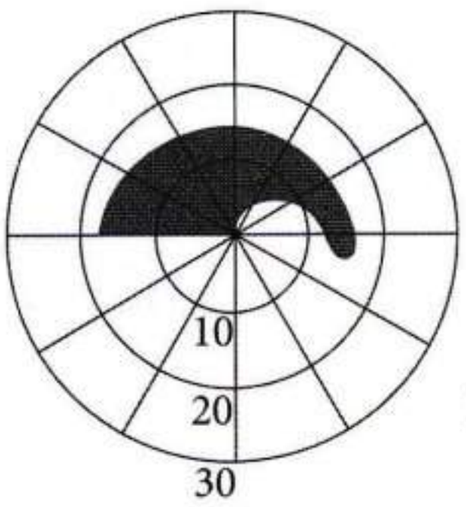
Vertical step → Loss of central field → Loss of temporal vision^{Q} (most resistant)



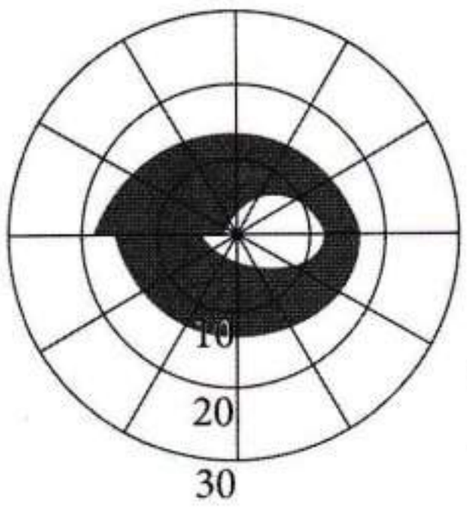
Paracentral scotoma



Seidel's scotoma



Bjerrum scotoma



Ring scotoma with ventral superior nasal step

EXTRA MILE

All **scotomas** (an area of reduced or total loss of vision, surrounded by a seeing area) in POAG are **Negative**, i.e. patient is unaware of the scotoma

Arcuate defects - in Bjerrum area

Mnemonic

Visual Field Defect Progression

I C(see)	–	**I**soptre **C**ontraction
B	–	**B**aring of **B**lind spot
P	–	Paracentral scotoma
Should	–	Seidel's
Be	–	Bjerrum/Arcuate
Regulated	–	Ring/Double arcuate
Stepwise	–	Nasal step and vertical step
Continuously	–	Central loss of vision
Through	–	Tubular vision
Treatment	–	Temporal loss of vision (Total blindness)

Characteristics of Glaucomatous Visual Field Defects

- Almost always localized
- Respect horizontal meridian
- Begin nasal to the blind spot
- Almost always detectable within the central 30°

Treatment

Medical Treatment[Q]

Mainstay – used as topical drops

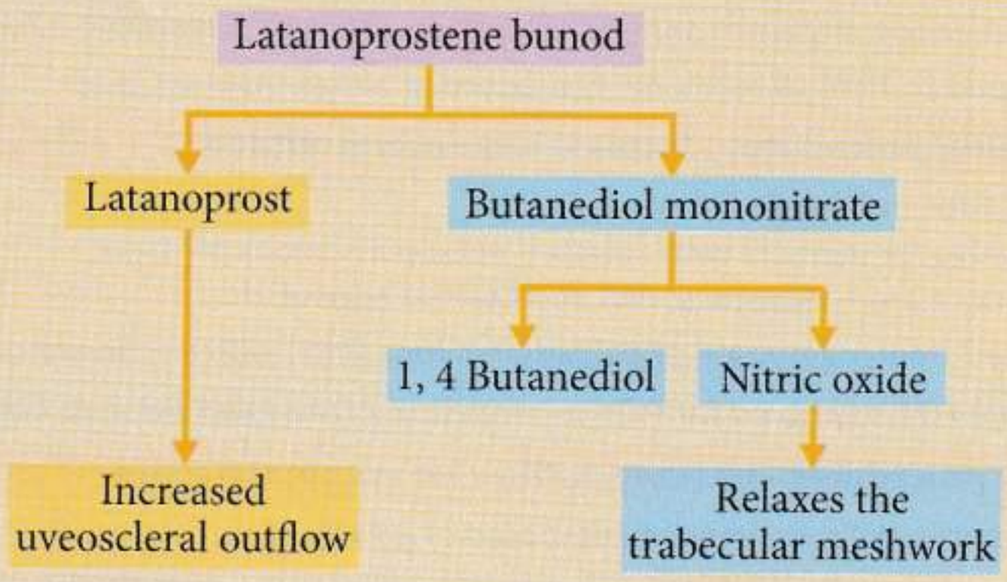
Correlate Box

Drug	Mechanism of Action	Ocular Side Effects	High Yield Points
β BLOCKERS			
• Timolol (0.25%, 0.5% BD) • Betaxolol (0.5% BD) – Selective	Decreased[Q] aqueous production (inhibition of cAMP)	• Allergic blepharoconjunctivitis • Ocular cicatricial pemphigoid • Superficial punctate keratitis • Corneal anesthesia • Keratoconjunctivitis sicca • Metipranolol: Granulomatous anterior uveitis • Betaxolol: Aphakic cystoid macular edema • NLD obstruction	• Contraindicated in Asthma, CHF, Diabetes[Q] • Show short termescape phenomenon
PROSTAGLANDIN ANALOGUES (PGF2α)			
• Latanoprost (0.005% OD) • Bimatoprost (0.03% OD) • Travoprost (0.004% OD) • Unoprostone (0.12–0.15% BD) • Tafluprost (0.0015% OD) → **preservative free**	Increased[Q] uveoscleral outflow	• Hyperchromic heterochromia iridis (Hyperpigmentation of iris and periocular skin)[Q] • Hypertrichosis (eyelash growth)[Q] • Uveitis[Q] • Reactivation of herpetic keratitis • Iris cysts • Conjunctival hyperemia • Cystoid macular edema[Q] • Allergic contact dermatitis • Choroidal effusions	• Contraindicated in hypertensive uveitis[Q] • **DRUG OF CHOICE for POAG[Q]** • Bimatoprost - FDA approved for treatment of Hypotrichosis • Used in PACG, if IOP elevation persists after peripheral iridectomy

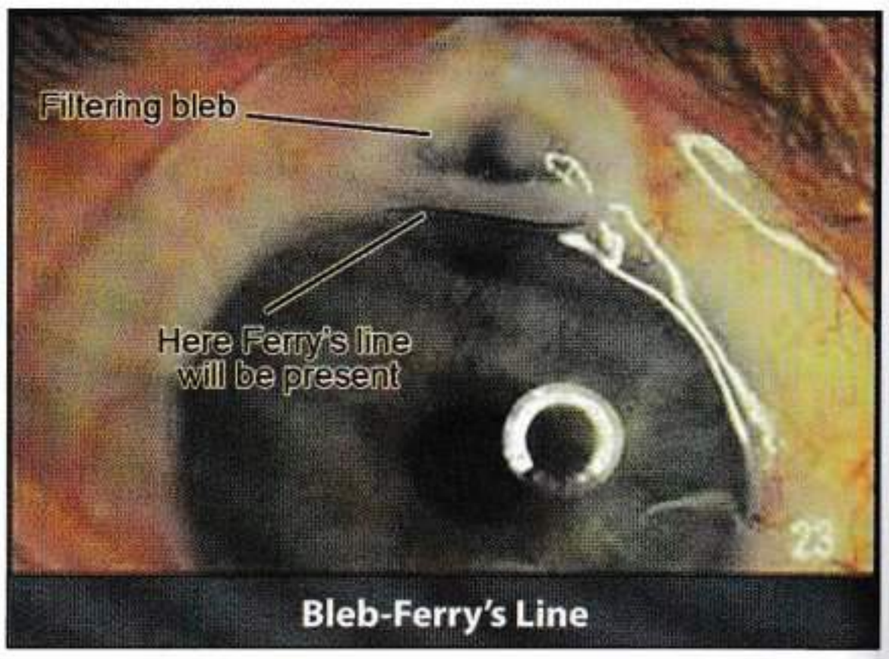
Contd...

Drug	Mechanism of Action	Ocular Side Effects	High Yield Points
α-ADRENERGIC AGONISTS			
– Apraclonidine (0.5% 1% TDS)	Decreased aqueous production (+) Increased Trabecular outflow	• Follicular conjunctivitis[Q] (Most significant) • Mydriasis • Upper eyelid retraction[Q]	• Choice for post laser IOP elevation
– Brimonidine (0.2% TDS)	Decreased aqueous production (+) Increased uveoscleral outflow	• Ocular allergies	• Bradycardia, hypotension **Apnea,**[Q] Drowsiness[Q] and CNS depression, thus, **CI in children** • Contraindicated in Parkinson's disease and hypertensive crisis
– Dipivefrin (0.1% TDS)		Black conjunctival pigmentation	• Used in Hypertensive uveitis[Q]
CARBONIC ANHYDRASE INHIBITORS			
– Dorzolamide (2%) – Brinzolamide (1%)	Decreased aqueous production[Q] (inhibit CA II isoform on ciliary muscle and sphincter pupillae)	• Metabolic acidosis and hypokalemia • Superficial punctate keratopathy • Myopic shift • Corneal decompensation in patients with Fuch's dystrophy and bullous keratopathy	• Contraindicated in sulfa allergy[Q] • Adjunct for POAG treatment
– Acetazolamide		• Urolithiasis	• **Not available topically**[Q]
CHOLINERGIC AGONISTS			
– Pilocarpine (1%)	Increased trabecular and uveoscleral outflow (m3 muscarinic receptor on ciliary muscle and sphincter pupillae)	• Uveitis • Pseudomyopia[Q] • Retinal detachment • Punctal occlusion • Browache	Useful in open angle glaucoma and angle closure glaucoma

Recent Advances

RHO KINASE INHIBITORS			
Netarsudil (0.02% OD) (Rhopressa)	Increases trabecular outflow by • Promoting actin-myosin contraction • Increasing actin stress fibers and focal adhesions & lowers episcleral venous pressure & decreased aqueous production by inhibition of norepinephrine transport	• Conjunctival hyperemia • Cornea verticillata • Conjunctival hemorrhage	• Adjunctive agent • DUAL inhibitor
NITRIC OXIDE DONATING PROSTAGLANDIN ANALOGUE			
Latanoprostene bunod (0.024%)		Same as prostaglandin F2α analogues	

Surgical Treatment



Bleb-Ferry's Line

- **Trabeculectomy** creates a fistula to allow aqueous outflow from anterior chamber to subtenon space creating a bleb.

  Most common cause of failure of surgery is scarring of filtering bleb, to prevent it antimetabolites such as mitomycin c and 5 fluorouracil are used.

- **Non-penetrating surgeries:** Deep sclerectomy, viscocanalostomy, canaloplasty
  (Have advantage of lesser incidence of postoperative hypotony, shallow AC and overfiltration)
- **Laser Trabeculoplasty (LT):** because the pathology is in the Trabecular meshwork, you repair the Trabecular meshwork by applying laser burns to a part of Trabecular meshwork, shrinking it, so that the remaining Trabecular meshwork stretches leading to enlargement of the existing spaces/holes in Trabecular meshwork

- ALT (Argon Laser)
- SLT (Q switched, frequency doubled Nd: YAG laser applied selectively to pigmented Trabecular meshwork)

Extra Mile

- Gonioprisms (Goldmann, Thorpe, Ritch, Latina lens) are used for visualization of angle during LT
- Side effects of Laser procedure
  - Transient IOP elevation – treat with Apraclonidine 1 hour before and after procedure
  - Iritis
  - Peripheral anterior synechiae
- In SLT, 50 burns (50 micron spot size) are applied over 180° of Trabecular meshwork
- SLT is the preferred laser procedure of **choice for prophylaxis of the fellow eye** in POAG[Q]

- **MIGS (Minimally Invasive Glaucoma Surgery)**

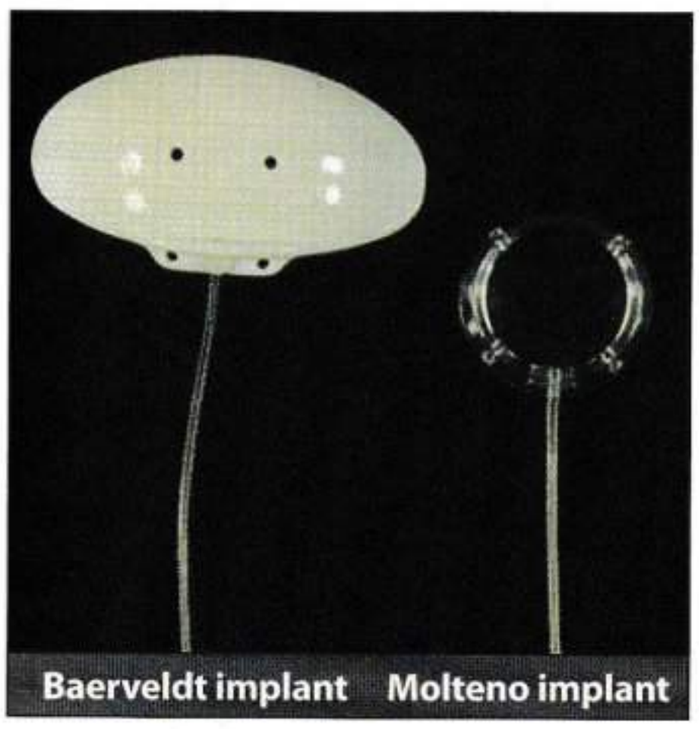
Recent Advances

The currently approved procedures work in three different areas of the eye

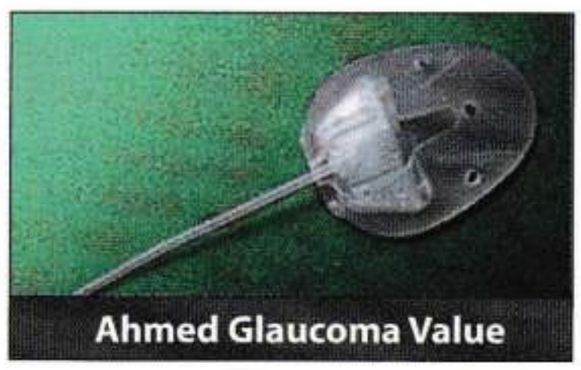
Canal based procedures - Increase Trabecular outflow	
iStent Micro Bypass	**Heparin-coated, non-ferromagnetic titanium stent** Implanted (*Ab interno* insertion into Schlemm's canal) through 1.5mm corneal incision **MC complications** are – Obstruction (4%) and Malpositioning (3%)
Kahook Dual Blade	*Ab interno* trabeculotomy using a single use, tapered, stainless steel blade
Trabectome	*Ab interno* trabeculectomy using combination of electrocautery
TRAB 360	*Ab interno* trabeculotomy - a flexible nylon-like trabeculotome is advanced into Schlemm's canal for 180° and then lysed (x2 to perform up to 360° trabeculotomy)
Ab interno canaloplasty (ABiC)	Cannulate and viscodilate Schlemm's canal – via clear corneal incision
GATT	*Ab interno* trabeculotomy with cannulation and unroofing of Schlemm's canal
Hydrus Microstent	Crescent-shaped scaffold (8-mm long) composed of nickel-titanium alloy
Suprachoroidal procedures – Increase Uveoscleral outflow	
CyPass Microstent	6.35mm long tube **polyimide** material Viable alternative for patients with elevated episcleral venous pressure MC complications are – **Hypotony,** PAS and Corneal edema
iStent Supra	Heparin-coated stent, composed of polyethersulfone (PES) with a titanium sleeve
Canal based and Suprachoroidal procedures are FDA approved for mild to moderate POAG in addition to Cataract surgery	
Subconjunctival procedures – increase outflow into subtenon space	
XEN gel stent	6-mm long translimbal tube implant composed of **gelatin** **Indicated for –** refractory glaucoma patients with failed surgical treatment or medically unresponsive POAG
InnFocus MicroShunt	*Ab-externo*, subconjunctival (via peritomy) insertion Composed of SIBS - poly(styrene-block-isobutylene-block-styrene)

- **Glaucoma Drainage Device (Tube Implants/Setons)**
  Consist of a silicone tube (mostly) the extends from AC to plate/disc beneath the tenon capsule allowing for drainage of aqueous.
  Used for uncontrolled glaucoma and for glaucoma with aniridia

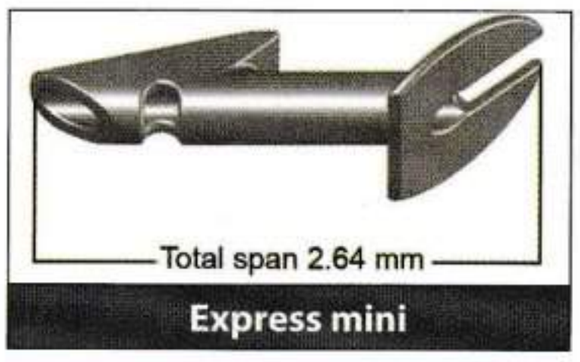
Open Tube (Nonvalved)	Flow Restricting (Valved)
• Baerveldt • Molteno • Schocket • Express Mini[Q] (Made of stainless steel)	• Ahmed glaucoma valve • Krupin



Baerveldt implant Molteno implant



Ahmed Glaucoma Value



Express mini

PRIMARY ANGLE CLOSURE GLAUCOMA (PACG)

Mechanism[Q]

Relative pupillary block (A)

Apposition of pupillary margin against lens surface in a mid-dilated (3.5–6 mm) pupil

↓

Aqueous cannot flow from PC to AC

↓

IRIS BOMBE (B)

Anterior iris bowing due to increased aqueous pressure in PC

↓

IRIDOTRABECULOCORNEAL (ITC) contact (C)

↓

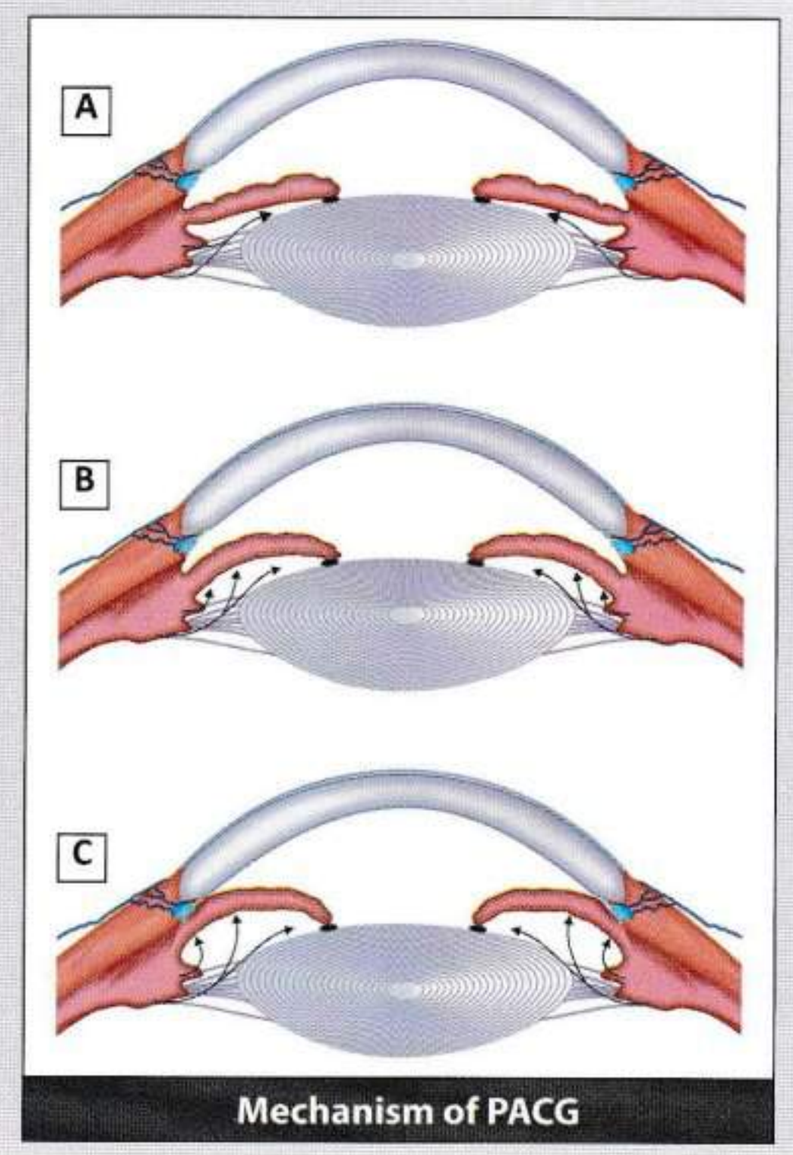
PERIPHERAL ANTERIOR SYNECHIAE (PAS)

Due to continued iris pushing anteriorly, iris comes in adhesion with cornea and Trabecular meshwork

↓

PACG

Central deep AC, peripheral shallow AC



Mechanism of PACG

Risk Factors

- Hypermetropia[Q] – Small axial length
- Small cornea (diameter)[Q]
- Shallow AC
- Relative anterior position of lens-iris diaphragm[Q]
- Females > males[Q]
- Plateau iris

Precipitated by dim light[Q], stress, near work, mydriatics[Q]
(all are factors which will dilate the pupil)

Classification

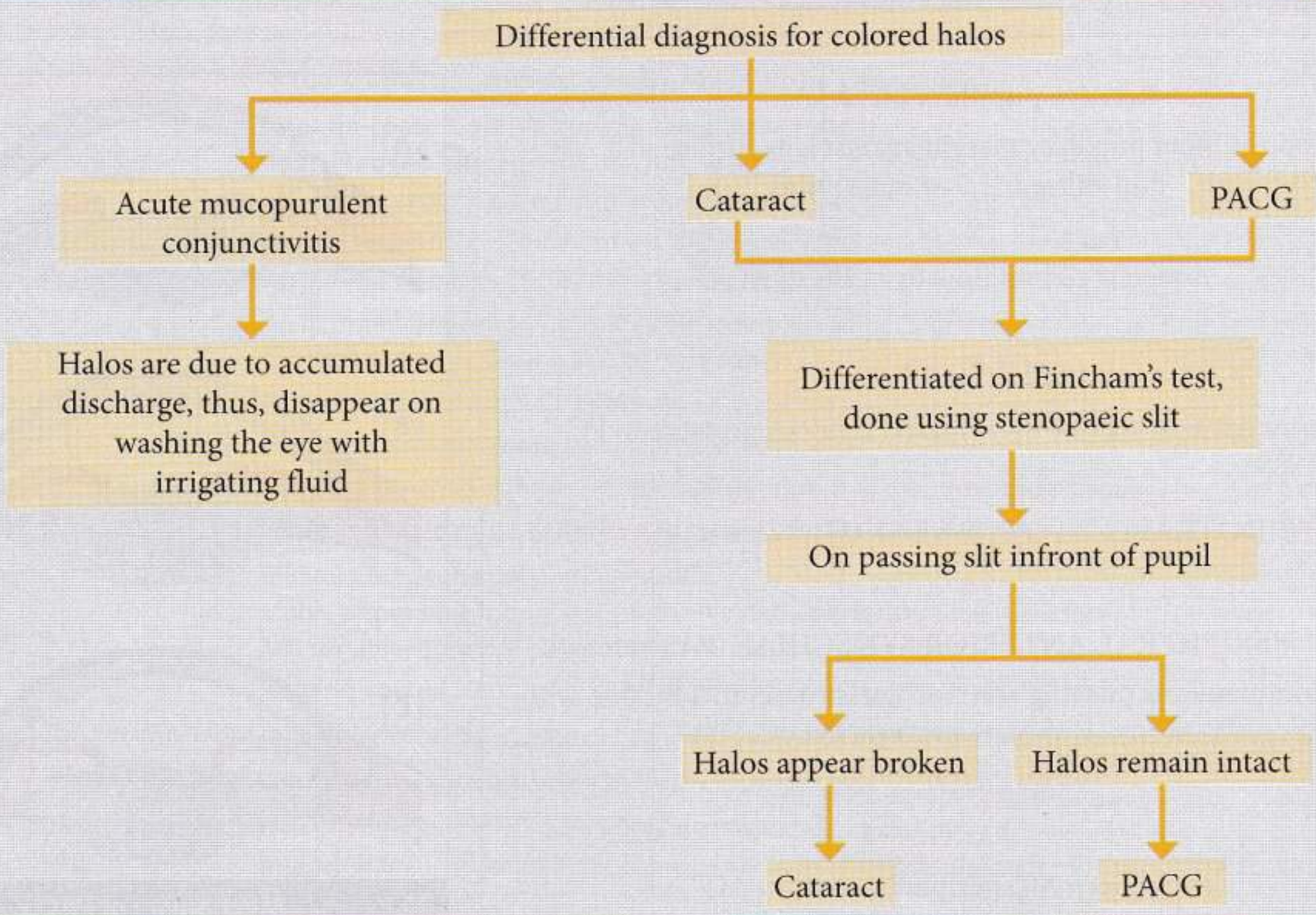
Primary angle closure suspect (PACS)	Primary angle closure (PAC)	Primary angle closure glaucoma (PACG)
Normal IOP, optic disc and visual field	Increased IOP, normal optic disc and visual field	Optic Neuropathy develops with visual field changes
Functional apposition (ITC) in ≥ 3 quadrants	Functional apposition (ITC) ≥ 3 quadrants	
NO PAS	PAS present	

Clinical Features

Subacute ACG

- C/O transient blurring of vision (smoke filled room)
- **Colored halos**[Q] around light, due to corneal epithelial edema[Q]
- Patients have shallow AC, and these symptoms occur **more often at night**, due to precipitating factors[Q] like dim light, mydriasis[Q]

HIGH YIELD


Differential diagnosis for colored halos
Acute mucopurulent conjunctivitis
Halos are due to accumulated discharge, thus, disappear on washing the eye with irrigating fluid
Cataract
PACG
Differentiated on Fincham's test, done using stenopaeic slit
On passing slit infront of pupil
Halos appear broken
Halos remain intact
Cataract
PACG

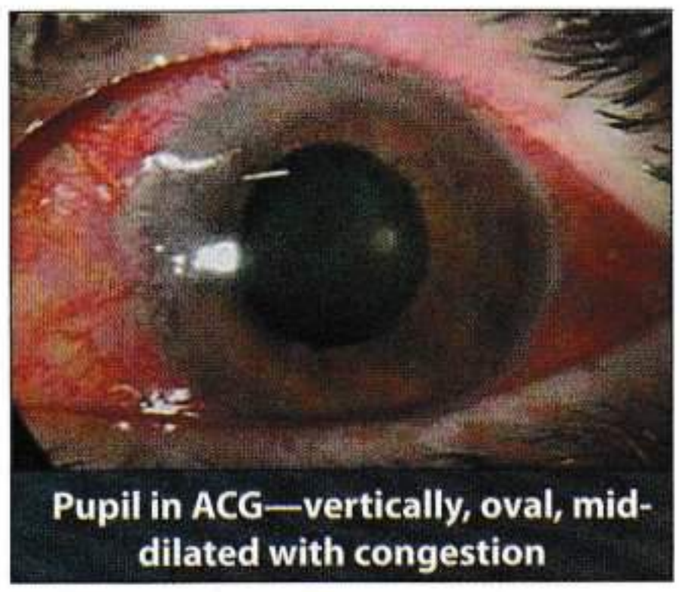
Acute ACG/Acute Congestive Glaucoma/Attack

- Symptoms
  - **Severe pain**— radiates along trigeminal nerve and may be associated with nausea, vomiting, profuse sweating
  - **Redness**
  - **Sudden** loss/**blurring of vision**—due to corneal edema, direct effect of raised IOP on optic nerve
- Signs
  - **IOP** is markedly raised – 40 mm Hg to 60 mm Hg
  - **On Digital tonometry (palpation) – Rock hard eye**
  - Conjunctival hyperemia – Circumcorneal congestion
  - **Eclipse sign** – shadow on nasal iris due to iris bombe.
  - **Pupil**–vertically oval[Q] (Irregular) mid-dilated, fixed[Q] (nonreactive to light and accommodation)

    Remember – Pupil in POAG is Normal

    Due to sphincter pupillae paralysis caused by raised IOP
  - Corneal edema
  - Shallow AC with aqueous flare[Q]
  - Sectoral iris atrophy with **posterior synechiae** (adhesion between lens and pupillary margin)
  - **Glaukomflecken** – anterior capsular opacities (cataract) due to lens epithelial ischemia or necrosis
  - Visual fields constriction of superior (upper) field.

Iris bombe – Anteriorly bowed/ convex iris



Pupil in ACG—vertically, oval, mid-dilated with congestion

Vogt's Triad

- Glaucomflecken
- Patchy iris atrophy
- Mid-dilated, non reacting pupil may be seen after an attack of PAC, irrespective of treatment.

Chronic ACG

- PAS may be seen on gonioscopy – usually **Broad based**, causing synechial angle closure > 180°
- Creeping angle closure – circumferential, slow spread of synechial closure form periphery toward Schwalbe line.
- Visual fields – central nasal step is most commonly seen.

Treatment

Reduction of IOP

IV Mannitol[Q]: 1 to 2 g/Kg, 25% solution over 30 minutes
Drug of choice for 'Acute' congestive Glaucoma[Q]

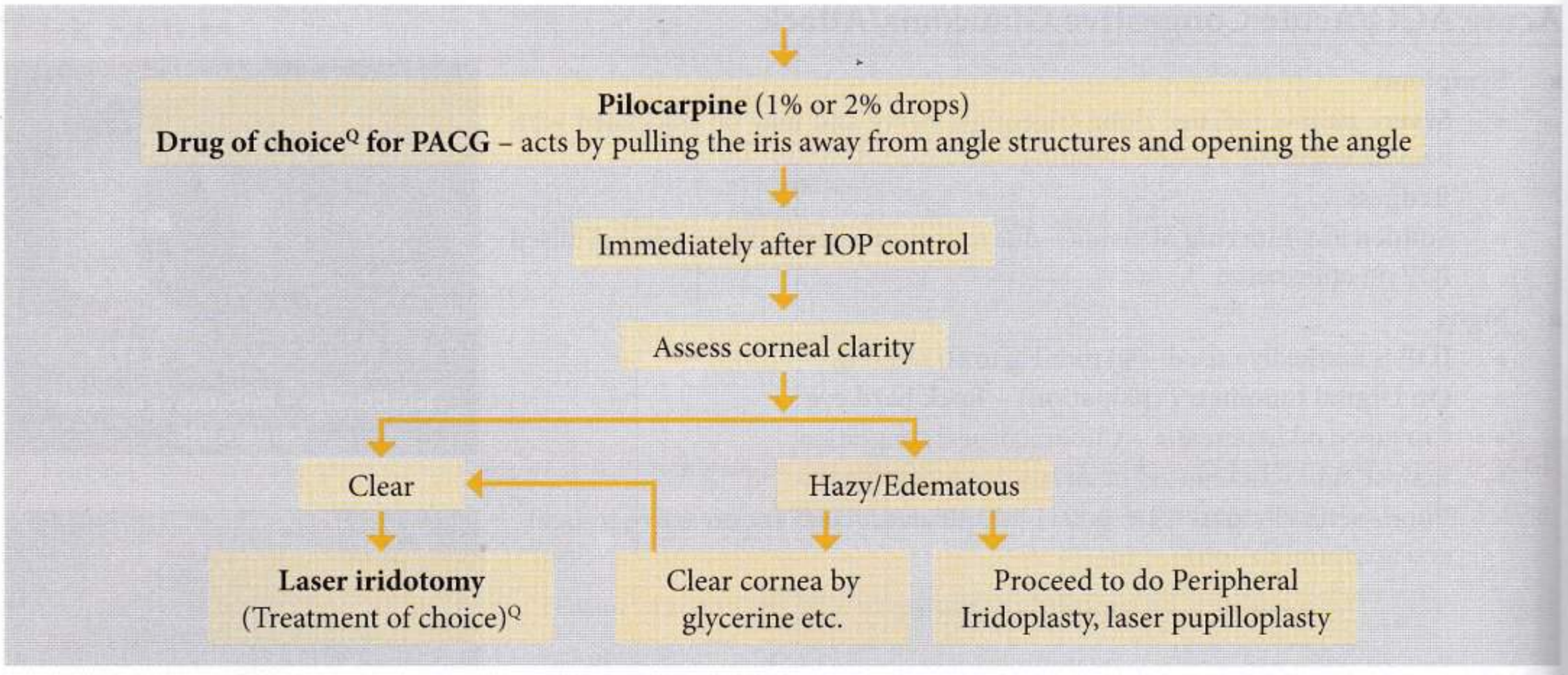
or

Acetazolamide: 250 mg-2 tab stat

or

Glycerin – orally 1 to 1.5 g/kg of body weight

Contd...


Pilocarpine (1% or 2% drops)
Drug of choice[Q] for PACG – acts by pulling the iris away from angle structures and opening the angle
Immediately after IOP control
Assess corneal clarity
Clear
Hazy/Edematous
Laser iridotomy
(Treatment of choice)[Q]
Clear cornea by
glycerine etc.
Proceed to do Peripheral
Iridoplasty, laser pupilloplasty

- Other modalities
  - Diode laser cytophotocoagulation – to relieve pain in absolute glaucoma, i.e., painful, blind eye with glaucomatous optic atrophy
  - Retrobulbar injection of alcohol[Q] – used to be given to treat Absolute (no visual potential) glaucoma.

HIGH YIELD

Laser Iridotomy

- Creation of a **hole in the peripheral iris** (it is like making a bypass for artery blockage-as the pupil is blocked, so make a bypass, a hole to allow aqueous to travel from PC to AC)
- Most commonly Pulsed **Nd: YAG laser** is used. Laser burns are placed (over Iris crypts) between the middle and peripheral one-third of iris, usually at **11o' clock or 1o' clock position** (superiorly) *Refer Image Based Question 19.*
- **Prophylactic laser treatment of choice for the Fellow eye-Laser Iridotomy**[Q], usually done at the same sitting

Complications of Laser procedures

- Corneal endothelial burns (with argon)
- Iris hemorrhage
- IOP spike (instill pilocarpine & alpha 2 agonist prelaser)
- AC inflammation with closure of iridectomy, formation of posterior synechiae, or raised IOP
- Cataract formation
- Corneal endothelial decompensation, malignant glaucoma, retinal damage, cystoid macular edema (all rare)

Provocative Tests[Q]

Open angle glaucoma	Angle closure glaucoma

• Water drinking test
• Bulbar pressure test
  ▪ Suda's test
  ▪ Blaxter test
• Priscoline test
• Caffeine test
• Amyl nitrate test
• Jugular vein compression test
	• Dark room test
	• Prone test
	• Dark room prone test
	• Mydriatic test
	• Reading test
	• Triple test (Mydriasis + Water drinking + pilocarpine)

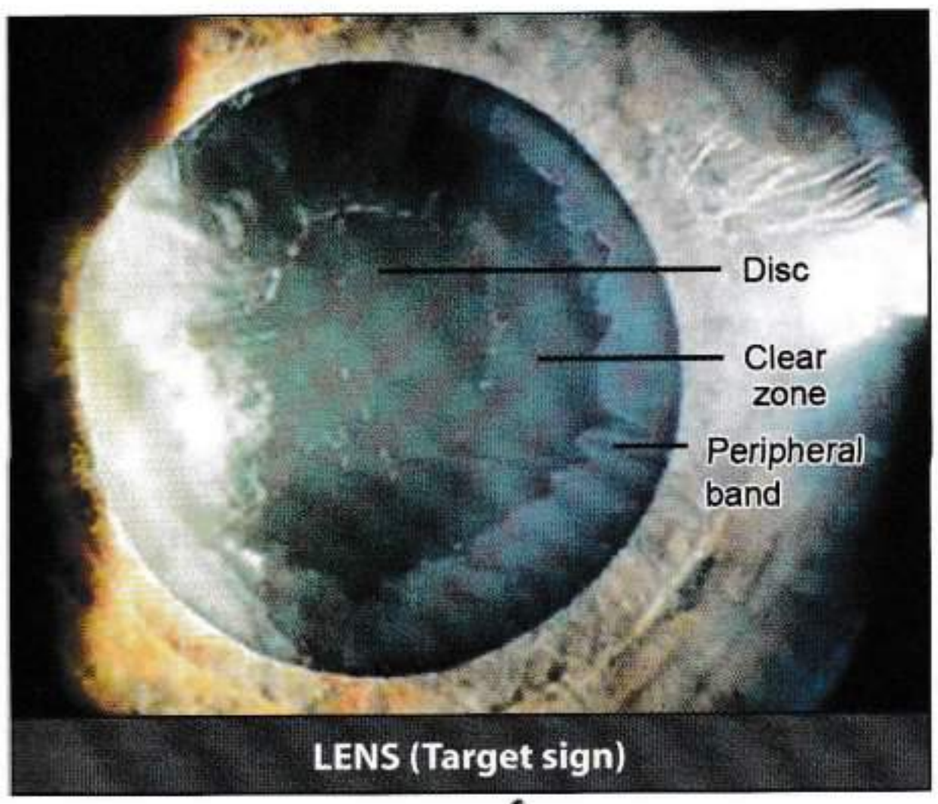
SECONDARY GLAUCOMA(S)

Pseudoexfoliation Syndrome/Glaucoma (PXF/PXG)

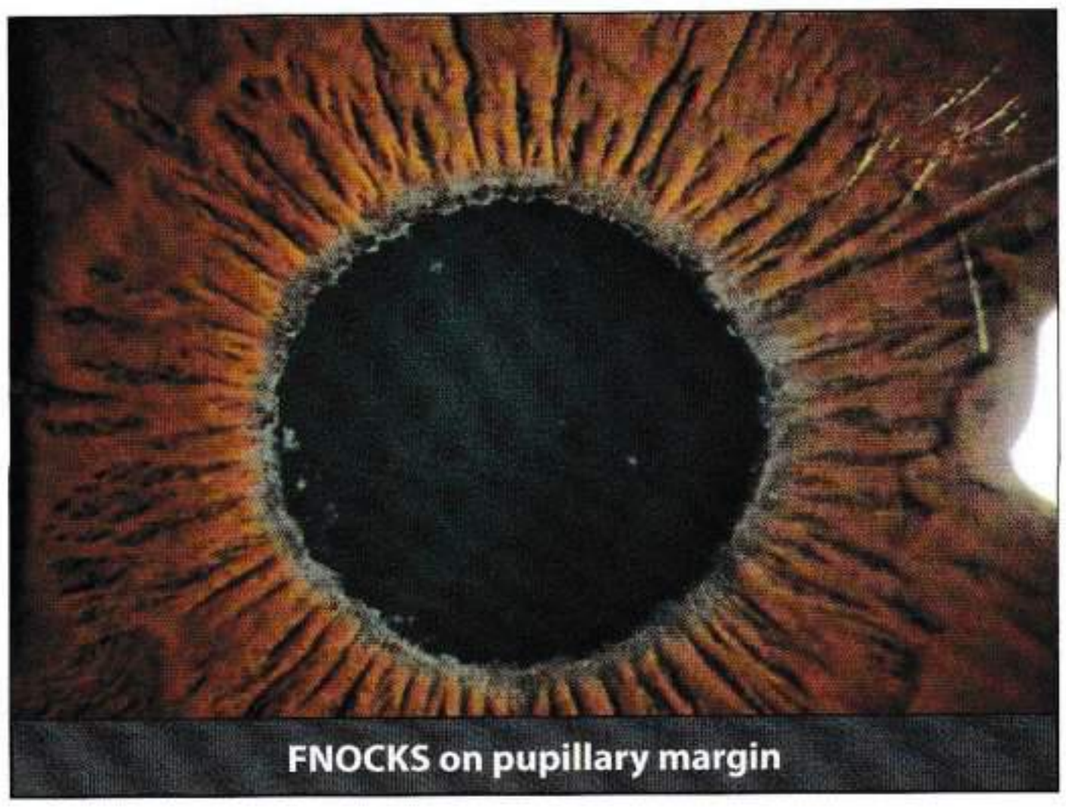
- Associated with mutations of LOXL 1 gene mutation (15q 24), which is essential for formation of elastin fibers.

Clinical Features

- 2° Chronic **open angle** glaucoma, mostly **unilateral**, due to clogging of the Trabecular meshwork by pseudoexfoliative material (Pseudoexfoliative material is produced by lens capsule, iris epithelium and corneal, vascular, schlemm canal endothelium).
- **Cornea:** Deposition of exfoliative material on endothelium
- **Lens:** Nuclear cataract and frosting of anterior lens capsule with **Target sign**.



LENS (Target sign)


FNOCKS on pupillary margin

- **Iris:** White flaky material deposited on the pupillary margin known as **Fnocks**.
- **Transillumination defects** (Moth Eaten) are also seen due to sphincter atrophy at the pupillary margin.
- Poor **Mydriasis** is a typical finding.
- Lens subluxation and phacodonesis (tremulousness or vibration of lens with movement of eye) due to ciliary **zonular dehiscence**.
- **Sampaolesi line** – accumulation of pigment along /anterior to Schwalbe line
- 'Dandruff like appearance due to deposition in trabeculum.

Treatment

Topical prostaglandin analogues (PGF2α) and laser trabeculoplasty are useful.

Pigmentary Glaucoma

- **MC in Young, Myopic Males**
- 35% pigmentary dispersion syndrome patients have pigmentary glaucoma (within 15 years).

Clinical Features

Sign	Site of pathology
2° Chronic **Open Angle** glaucoma	Due to blockage of Trabecular meshwork by pigment granules
Cornea – **Krukenberg spindle**	Vertical, spindle shaped deposition of pigment on endothelium
Iris-mid-peripheral radial Transillumination defect	Due to pigment epithelial atrophy
Scheie line/Zentamyer line	Deposition of pigment on peripheral posterior lens capsule, at the insertion of ciliary zonules
Sampaolesi line	May be seen

Treatment

- α-Adrenergic antagonists (Topical): Thymoxamine (0.5%), Dapiprazole (1.6%) may be used for their miosis which can relieve the mechanism of pigment dispersion (iris posterior pigment epithelium rubbing against lens capsule)
- Laser trabeculoplasty
- Trabeculectomy

Posner Schlossman Syndrome/Glaucomatocyclitic Crisis

Clinical Features

- Unilateral, Acute 2° **open angle** glaucoma[Q] characterized by recurrent attacks of mild **anterior uveitis** and marked (40–60 mm Hg) elevation of IOP, due to acute trabeculitis
- Most commonly seen in young male adult, who may be positive for HLABw 54 or have associated herpes simplex **(HSV) infection**
- **White eyes** (no redness, even though uveitis present), with all signs of anterior uveitis except posterior synechiae.

Treatment

- Corticosteroids – to control inflammation/uveitis
- Antiglaucoma drugs – Topical Dipvefrin[Q], Apraclonidine, Timolol

Latanoprost and Pilocarpine are contraindicated as they induce uveitis as a side effect[Q]

HIGH YIELD

Glaucoma in Uveitis

- Hypertensive uveitis (2° OAG) – in acute anterior uveitis
- Post-inflammatory glaucoma (2° ACG) – due to posterior synechiae in chronic anterior uveitis
- Posner-Schlossman syndrome

Malignant/Ciliary Block Glaucoma/Aqueous Misdirection Syndrome

Cause

Due to incisional, laser[Q] Surgeries[Q] for glaucoma or cataract (Pseudophakia or Aphakia) or associated with endophthalmitis by Fungal keratomycosis or Nocardia

↓

Ciliolenticular block occurs – where tips of ciliary processes rotate forward and press against the lens equator or anterior hyaloid (in aphakia)

↓

Leads to **posterior diversion of aqueous flow** (toward the vitreous from PC)

↓

Aqueous accumulates in PC and vitreous, thus **pushes the iris-lens diaphragm forward**

↓

AC becomes shallow[Q] (both central and peripheral)
2° **ACG without pupillary block** with severe pain

Treatment

- Cycloplegics (Atropine[Q], Homatropine) – **Drug of choice** – work by relaxing ciliary muscle and thus tightening the ciliary zonules → pull the lens backward → break the ciliolenticular block
- Hyperosmotic agents and aqueous suppressants
- **Surgical treatment**[Q] (Laser photocoagulation, Trans-scleral diode laser photocoagulation, transcorneal needling, posterior sclerotomy and air injection) if medical management is not effective for 5 days.

EXTRA MILE

Inverse Glaucoma

- Can be due to **microspherophakia**, **ectopia lentis**, **malignant glaucoma** - cause 2°ACG
- In all the above cases, 2° ACG is precipitated by Pilocarpine (instead of being relieved), as pilocarpine catches the lens in between the pupil on constriction, thus, precipitates pupillary block and also leads to anterior movement of lens by slackening of ciliary zonules.

Plateau Iris

- Anterior insertion of iris leading to closure of angle on pupillary dilatation due to bunching of peripheral iris in the angle.
- Treatment is Topical pilocarpine drops and laser peripheal iridoplasty (PI)

Shallow AC with patent Iridotomy: Malignant glaucoma or Plateau iris

Lens-Induced Glaucoma

Name	Type	Cause/Mechanism	Treatment
Phacomorphic	2°ACG	Intumescent (swollen) cataract causing **pupillary block**	Lens extraction
Phacotopic	2°ACG	Anterior subluxation/dislocation of lens, as in ectopia lentis or microspherophakia[Q]	Atropine and peripheral iridotomy (PI)
Phacolytic	2°OAG[Q]	Hypermature senile cataract (Morgagnian)[Q] ↓ Soluble **lens protein leak** into aqueous through defect in lens capsule ↓ Clog Trabecular meshwork	Cataract extraction with thorough AC wash
Phacoanaphylactic	2°OAG	After cataract surgery or penetrating injury ↓ Due to induced hypersensitivity to residual lens particles	Steroids ↓ removal of lens particles

Ca oxalate/Cholesterol crystals along with flare are helpful diagnostic sign of phacolytic glaucoma.

Neovascular Glaucoma (NVG)

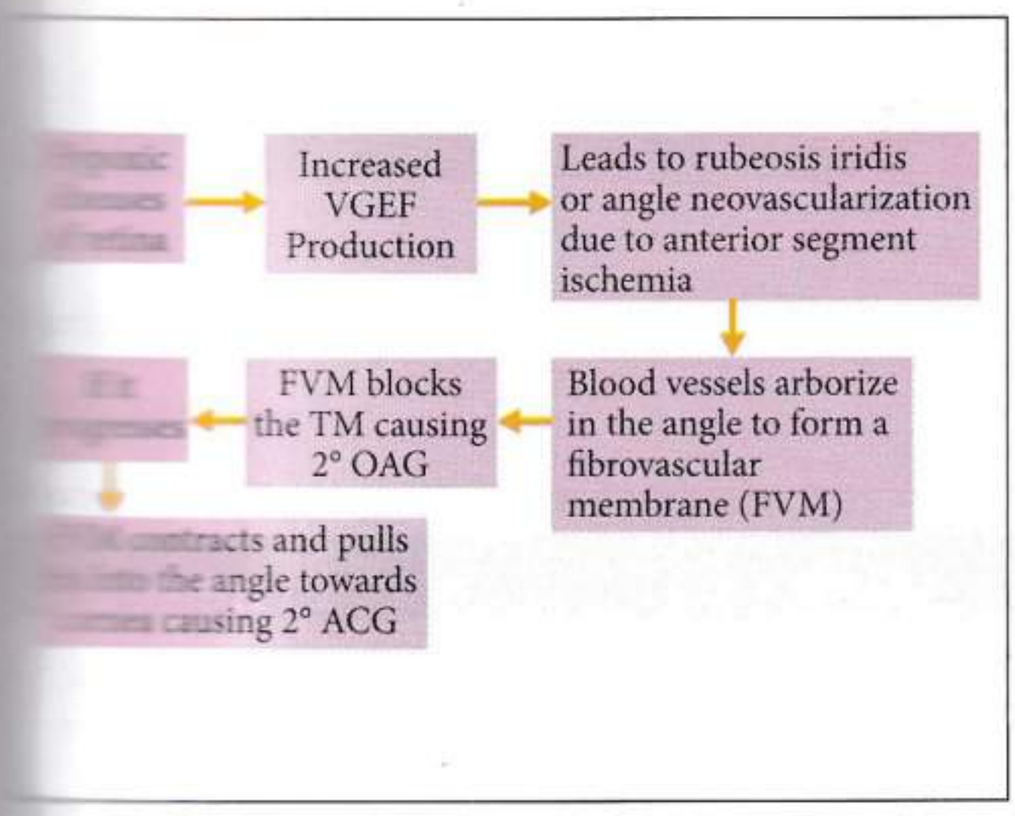
Glaucoma occurring due to diffuse and chronic retinal ischemia induced Rubeosis Iridis (Neovascularization of Iris-NVI)

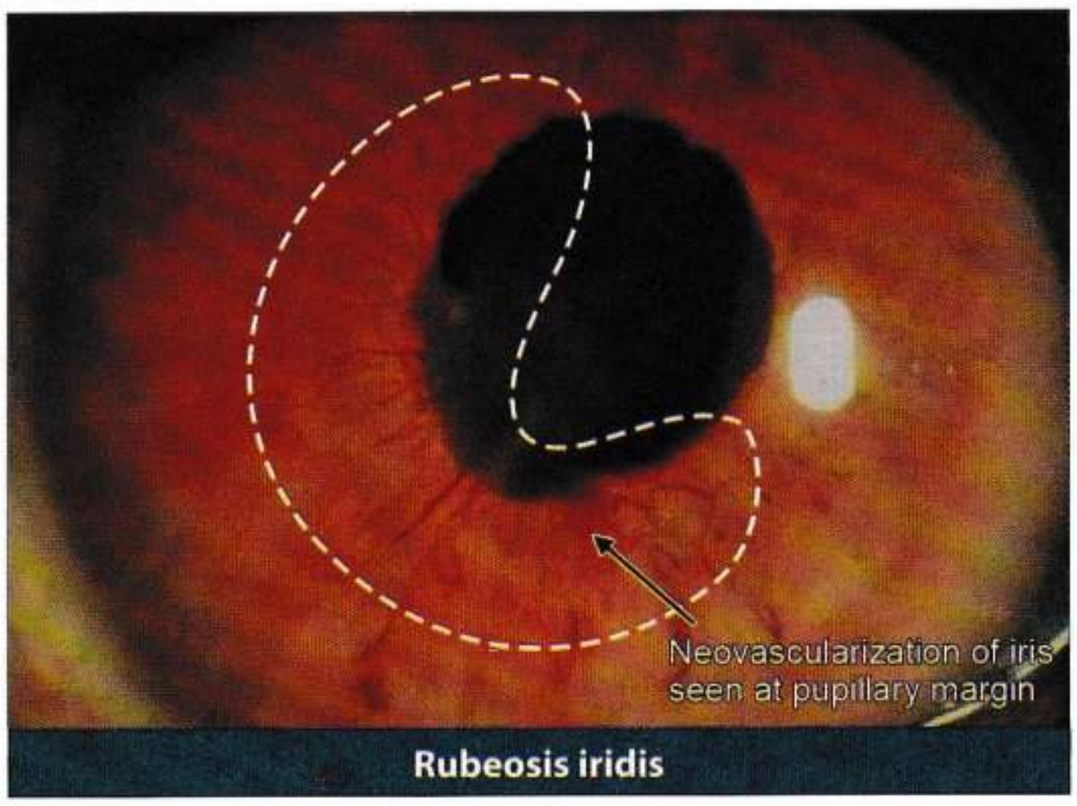
Causes

- Diabetic Retinopathy (**Most common**)[Q] > CRVO[Q] > Carotid artery obstructive disease
- Other causes: Uveitis[Q] (VKH syndrome, FHI[Q]), Intraocular tumors, Irradiation

NVG in CRVO is known as 100-day glaucoma[Q]

Pathogenesis


Increased VGEF Production
Leads to rubeosis iridis or angle neovascularization due to anterior segment ischemia
Blood vessels arborize in the angle to form a fibrovascular membrane (FVM)
FVM blocks the TM causing 2° OAG
contracts and pulls into the angle towards causing 2° ACG



Rubeosis iridis

Treatment

- **Treatment of choice:** Pan retinal photocoagulation[Q] (PRP), done at the first sign of rubeosis, prophylactically to induce regression of neovascularization
- Intravitreal Anti-VEGF drugs
- If 2°ACG has developed (with active rubeosis), it indicates poor/Nil Visual prognosis—DIODE laser cyclophotocoagulation is done to relieve pain.
- Glaucoma drainage devices (Seton surgery)

Iridocorneal Endothelial (ICE) Syndrome

- Unilateral, primary corneal **endothelial** abnormality (showing a **silver hammered** appearance) usually associated with Glaucoma (2° ACG) and iris atrophy[Q]
- **Pathognomonic feature:** On specular microscopy, endothelial cells appear dark with a light central spot and show pleomorphism
- **Clinical variants**

Progressive iris atrophy	**Corectopia** (malposition of pupil), **Polycoria** (presence of 2 or more pupils), hole formation due to IRIS atrophy[Q]
Chandler syndrome (Most Common variant)	Corneal edema
Cogan-Reese syndrome	Nodular, pigmented lesions on iris (Iris Nevus)

- Viral mechanism, associated with HSV has been suggested.

Silver hammered corneal endothelium

Posterior Polymorphous Corneal Dystrophy

- Bilateral, AD, primary corneal **endothelial** abnormality
- Presents with blisters/vesicles in cornea and associated with glaucoma in 15% cases

PRIMARY CONGENITAL GLAUCOMA

Classification

	Presentation/clinical onset	Distribution
Newborn] Primary congenital	at birth (intrauterine)	40%
Infantile] glaucoma (PCG)	< 3 years	55%
Juvenile	3 –16 years	5%

Pathogenesis

Trabeculodysgenesis or Goniodysgenesis (no defects in iris or cornea)

Clinical Features

Symptoms

Blepharospasm
Photophobia (earliest symptom[Q] – due to corneal edema)
Lacrimation (most common)[Q]

Mnemonic

B elow
P overty] Triad of symptoms
L ine

Signs

Anterior Segment

Due to high IOP, cornea stretches (neonatal eyeball is distensible) causing **endothelium to break**

↓

Endothelium is not able to perform its function of maintaining corneal transparency

↓

Corneal Haze[Q]/Ground glass appearance – **Earliest Sign**

↓

Progression leads to breaks in Descemet membrane which appear as corneal opacities lines with a double contour – **HAAB'S STRIAE**[Q]

HIGH YIELD

- Haab's striae usually occur only in the first 2 years
- Characteristically oriented Horizontally or Concentric to limbus
- Persist even after control of glaucoma as a sign of early onset glaucoma
- If breaks are seen to be vertical or oblique – due to trauma with forceps during delivery

Haab's striae

↓

Continued increased IOP causes distention of the whole eyeball known as **BUPHTHALMOS**, leading to

- Enlargement of corneal diameter **>13 mm**
- **Sclera** stretches, becomes thinner, eye appears **blue**
- AC deepens
- Axial length of eye increases → Causes myopia → Can cause anisometropic amblyopia

Lens

Anteroposteriorly flat[Q] with backward subluxation[Q]

Optic Disc Cupping

Gonioscopic Findings (Koeppe Goniolens)

- Anterior (flat) iris insertion
- Barkan membrane[Q] (translucent angle structures)
- Loch Ness Monster phenomenon (loops of vessel seen in angle above root of iris)

Congenital glaucoma

BLUE eyes Hypnotize Yo Yo Honey Singh

Treatment

- Medical treatment with β blockers and carbonic anhydrase inhibitors (Dorzolamide) is not very effective
- **Surgical**
  - Trabeculotomy + Trabeculectomy[Q] – **Treatment of choice**
  - Trabeculotomy[Q] – second treatment of choice
  - Goniotomy – **Treatment of choice if clear cornea**[Q]

Causes of visual loss in primary congenital Glaucoma

- Corneal opacity
- Optic nerve damage
- Retinal detachment
- Anisometropic or strabismic Amblyopia

Mnemonic

Signs of Congenital Glaucoma – $(ABCH)_2$

A nteroposteriorly flat lens
Anisometropic amblyopia
B uphthalmos
B lue eyes (scleral thinning)
C orneal diameter > 13 mm
C upping
H aze-corneal
H aab's striae

SECONDARY CONGENITAL[Q]/DEVELOPMENTAL GLAUCOMA

- Usually due to iridotrabeculodysgenesis or irdiocorneal[Q] dysgenesis (**Iris and cornea are also involved contrary to primary congenital glaucoma**)
- **Causes**
  - **Axenfeld-Rieger Syndrome:**
    - AD (PITX2 Gene), bilateral condition.
    - Presents with **posterior embryotoxon (anteriorly displaced prominent Schwalbe line)**, Corectopia, iris atrophy, polycoria with glaucoma in 50% cases
  - **Peters Anomaly:** Sporadic, bilateral condition.
    - Presents at birth with central corneal abnormality.
    - Glaucoma is most frequently associated ocular abnormality
  - **Aniridia:** Bilateral, congenital absence of iris.
    - Presents with glaucoma (75%), corneal opacity, pannus and superior ectopia lentis
  - Phakomatoses (**NF-1, Sturge-weber[Q] syndrome**)
  - Lowe syndrome
  - Stickler syndrome
  - Cystinosis
  - Chromosomal disorders – Trisomy, 21, 18, 13

LAST MINUTE REVISION – ONE LINERS

- Juxtacanalicular Trabecular meshwork offers maximum resistance to aqueous outflow
- Goldmann's applanation tonometry – Gold standard
- Rebound tonometry – Choice for self-tonometry
- Non-contact tonometry (NCT) – Choice for screening
- Mackay-Marg Tonometer/Pneumatic Tonometer – Choice for irregular, edematous cornea
- Dynamic contour testing – Choice for post-refractive surgery
- Gonioscopy is contraindicated in a dilated pupil
- Gonioscopy-principle-Eliminate total internal reflection
- Optic disc evaluation should be done in a dilated pupil
- IOP measurement is directly proportional to corneal thickness
- Eclipse sign is seen in angle closure glaucoma or shallow anterior chamber
- Perimetry is used for visual (central 30°) field examination
- Visual acuity and pupil are normal in POAG, whereas, sudden, painful loss of vision with congestion and vertically oval, mid-dilated fixed pupil is seen in Acute ACG
- Isopter contraction is the earliest visual field defect and paracentral scotoma earliest clinically significant visual field defect
- Temporal visual field is most resistant to visual loss
- Latanoprost is the DOC for POAG
- IV mannitol is the DOC for acute ACG and Pilocarpine for ACG
- Laser trabeculoplasty is done for OAG and Laser iridotomy done for ACG
- Vogt triad consists of Glaukomflecken, iris atrophy and sphincter pupillae atrophy. It indicates previous attack of ACG
- Hypersecretory glaucoma is caused by epidemic dropsy
- Buphthalmos, Haab's striae, Photophobia, Lacrimation are seen in congenital glaucoma
- Trabeculectomy with Trabeculotomy in the TOC in PCG
- 100 day glaucoma occurs in CRVO
- Mid peripheral iris trans-illumination defects are seen in pigmentary glaucoma as opposed to pupillary margin defects in pseudoexfoliative glaucoma.
- **Genetics in glaucoma**

	Inheritance	Genes
Primary open angle Glaucoma (POAG)	AD	Myocilin – MYOC/TIGR (1q24) Optineurin – OPTN[Q] (10p14) WDR 36 (5q22.1)
Primary congenital Glaucoma (PCG)	Mostly – Sporadic MC inheritance – AR	CYP1B1 – GLC3 locus (2p22) LTBP 2 – GLC3C locus (14q24) MYOC (1q24)
Juvenile onset open angle glaucoma	AD	MYOC
Pseudoexfoliative glaucoma		LOXL1
Axenfeld rieger syndrome	AD	PIT X 2 (4q25)
Aniridia	MC inheritance – AD Sporadic AR (Gillespie syndrome)	PAX 6 (11p13)

- Krukenberg spindle seen in pigmentary glaucoma
- Glaukomflecken are pathognomonic of PACG.

IMAGE-BASED QUESTIONS

There are multiple probable questions that can be asked on a single image.

Question numbers 1 and 2 are based on Image 1.

Image 1

1. **Which procedure is being done in the patient?**
   a. Applanation tonometry
   b. A scan ultrasonography
   c. Indentation tonometry
   d. Keratometry
2. **Which of the following is not true about Schiøtz Tonometer?**
   a. The shape of deformation of cornea is a truncated cornea
   b. Due to inadvertent accommodation during the procedure, there is lowering of IOP during measurement
   c. Friedenwald Nomogram is used as IOP pressure conversion tables
   d. If the scale reading is less than 4 with a starting weight of 5.5 g, additional weight is added

Question numbers 3 to 5 are based on Image 2.

Image 2

3. **All of the above signs can be seen in the above anterior segment image except**
   a. Polycoria
   b. Corectopia
   c. Iris atrophy
   d. Ectropion uveae
4. **The above is an image of the anterior chamber of a 35 year old woman who was being treated for right eye glaucoma. There was no history of trauma and the left eye was normal. What is the most likely diagnosis?**
   a. Posterior polymorphous corneal dystrophy
   b. Axenfeld-Rieger syndrome
   c. ICE syndrome
   d. Aniridia
5. **All of the following are features for a 35 year old female patient with the above anterior segment photograph except**
   a. Angle closure glaucoma is commonly seen to occur
   b. The primary pathologic change occurs in the corneal epithelium
   c. A retrocorneal membrane is seen on light microscopy
   d. Laser trabeculoplasty is not done in the early stages of glaucoma

Question numbers 6 to 8 are based on Image 3.

Image 3

6. **All of the following refractive changes will be found, except**
   a. Astigmatism
   b. Myopia
   c. Amblyopia
   d. Hypermetropia
7. **What is the treatment of choice for the infant in the photograph?** ***(Recent pattern July 2015)***
   a. Trabeculectomy
   b. Trabeculotomy
   c. Goniotomy
   d. Dorzolamide
8. **The horizontal diameter of cornea for the infant in the above photograph is likely to be**
   a. 9.5 mm
   b. 10.5 mm
   c. >12 mm
   d. >13 mm

Most Recent Image-based Questions of 2019-2017 are given at the end

Question numbers 9 to 12 are based on Image 4.

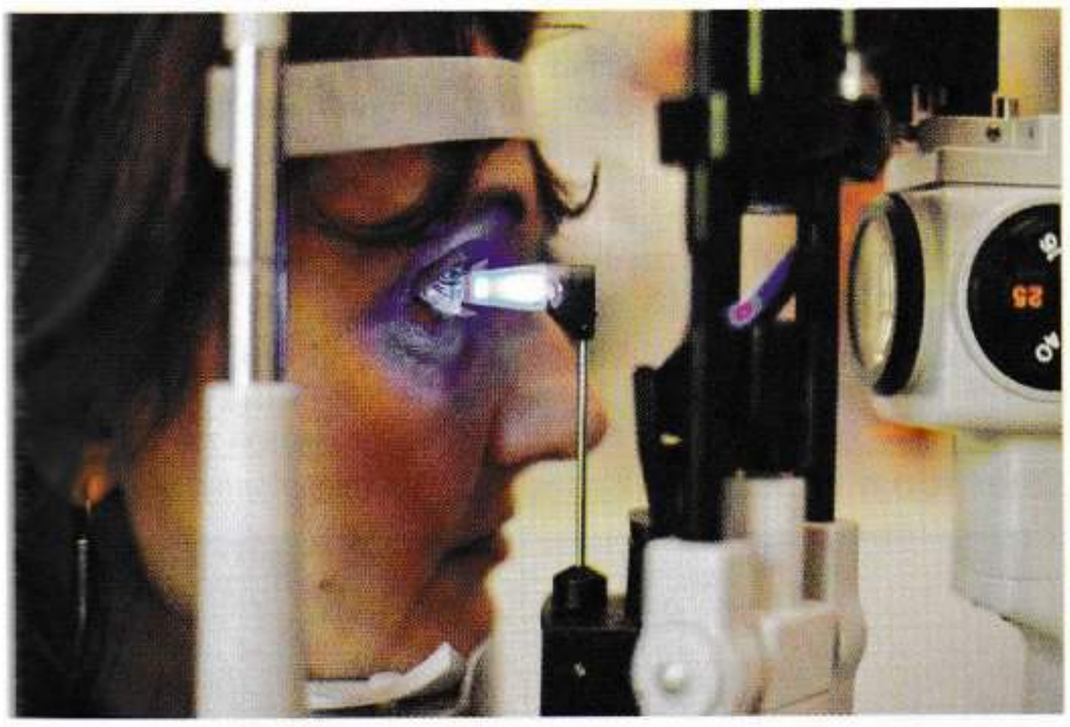


Image 4

9. **Identify the test shown below** *(AIIMS May 2017)*
   a. Tonometry
   b. Laser interferometry
   c. Pachymetry
   d. Biometry

10. **All of the following are true about the above instrument except**
    a. Based on the Imbert-Fick law
    b. Type of Variable force tonometer
    c. 3.06 mm of the cornea is applanated by GAT
    d. Cornea is stained with Rose Bengal

11. **An 18 year old undergoes LASIK surgery for 6D of myopia. On the 7th postoperative day, her IOP is measured by the above instrument. What would you expect?**
    a. False high IOP
    b. Normal IOP
    c. False low IOP
    d. Low IOP

12. **Which of the following is the correct method to view the Applanation tonomtery rings?**
    a.

    b.

    c.

    d. Any of the above

Question numbers 13 to 17 are based on Image 5.

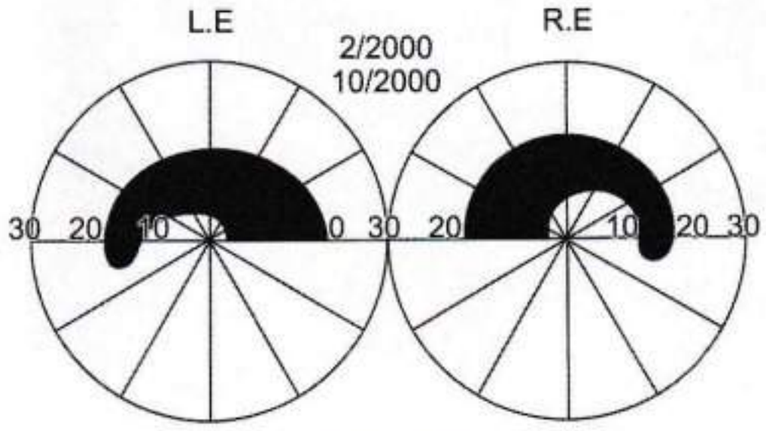


Image 5

13. **The visual field defect seen in the above image is**
    a. Seidel's scotoma
    b. Tubular vision
    c. Bjerrum scotoma
    d. Double arcuate scotoma

14. **A 60 year old gentleman comes to you because he cannot see clearly for near. His present reading glasses are 5 year old. He is otherwise fit. His visual acuity is 6/5 in both eyes corrected with glasses. His refractive error is -2 diopter spheres in both eyes. On examination his pupillary response is normal and anterior segment examination is normal with deep anterior chambers. His intraocular pressure recorded as 28 and 30mm Hg in right and left eye respectively. On direct ophthalmoscopy he has got a cupping of 0.6 in both eyes with nerve fiber layer hemorrhage along the superior margin of the left optic disc. Visual field examination reveals the above image. The most likely diagnosis is?**
    a. Ocular hypertension
    b. Primary open angle glaucoma
    c. Pseudoexfoliative glaucoma
    d. Secondary glaucoma

15. **The above visual field is seen in which of the following**
    a. Optic disc drusen
    b. Chorioretinal lesions
    c. Pituitary adenoma
    d. Open angle glaucoma

16. **This 60 year old woman, with the above visual field defect has been diagnosed as a case of primary open angle glaucoma. Which part of the visual field will be the most resistant to progressive glaucomatous visual field loss?** *(Recent Question 2018)*
    a. Central vision
    b. Nasal peripheral vision
    c. Superior vision
    d. Temporal peripheral vision

17. **A 60 year old gentleman comes to you because he cannot see clearly for near. His present reading glasses are 5 year old. He is otherwise fit. His visual acuities 6/5 in both eyes corrected with glasses. His refractive error is -2 diopter spheres in both eyes. On examination his pupillary response is normal and anterior segment examination is normal with deep anterior chambers. His intraocular pressure recorded as 28 and 30mm Hg in right and left eye respectively. On direct ophthalmoscopy he has got a cupping of 0.6 in both eyes with nerve fiber layer hemorrhage along the superior margin of the left optic disc. Visual field examination reveals the above image. What is the treatment of choice for the patient?**
    a. Topical Latanoprost QID
    b. Laser trabeculoplasty
    c. Topical Timolol BD
    d. Topical Latanoprost OD

Most Recent Image-based Questions of 2019-2017 are given at the end

Question number 18 is based on Image 6.

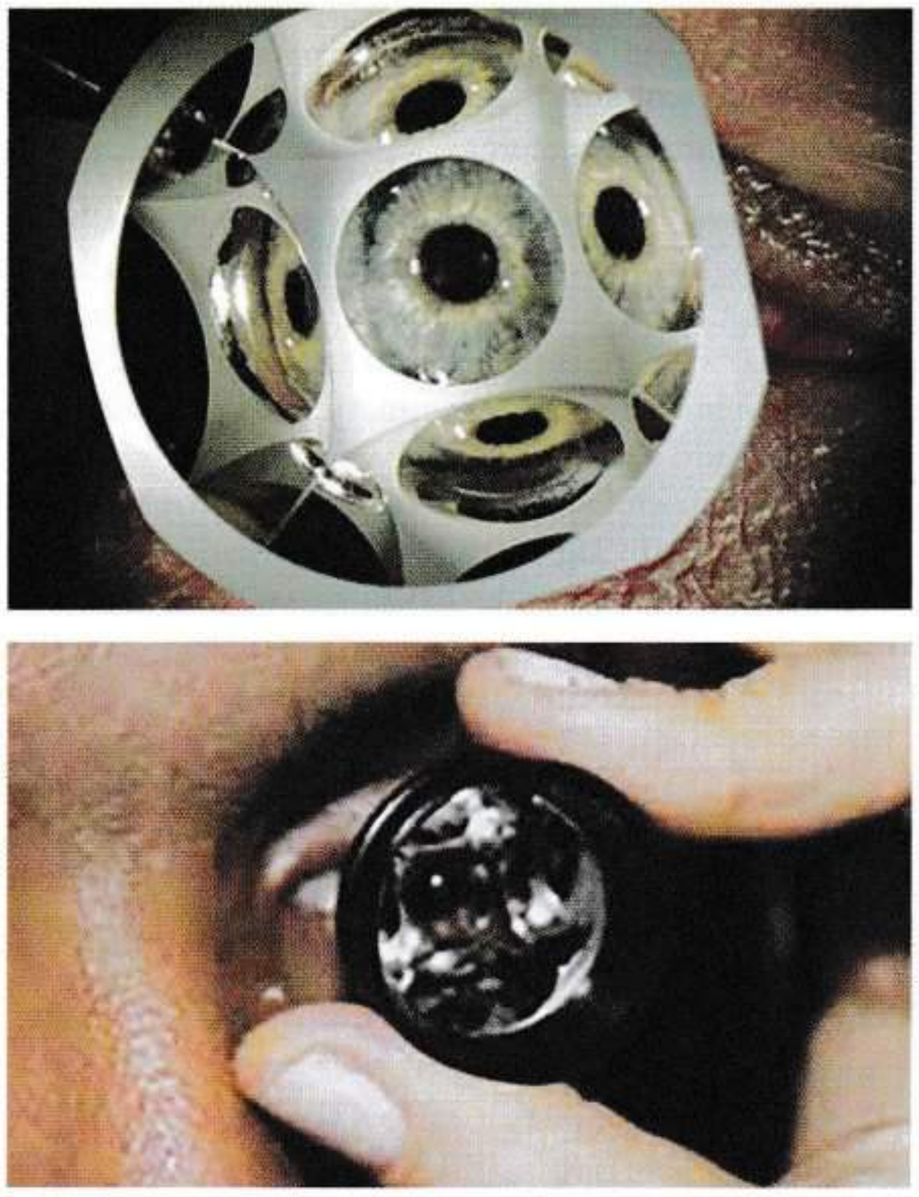


Image 6

18. **The instrument is used**
    a. To visualize the Purkinje images
    b. To perform Laser Trabeculoplasty
    c. To examine the angle of anterior chamber
    d. To measure the corneal curvature

Question numbers 19 to 21 are based on Image 7.

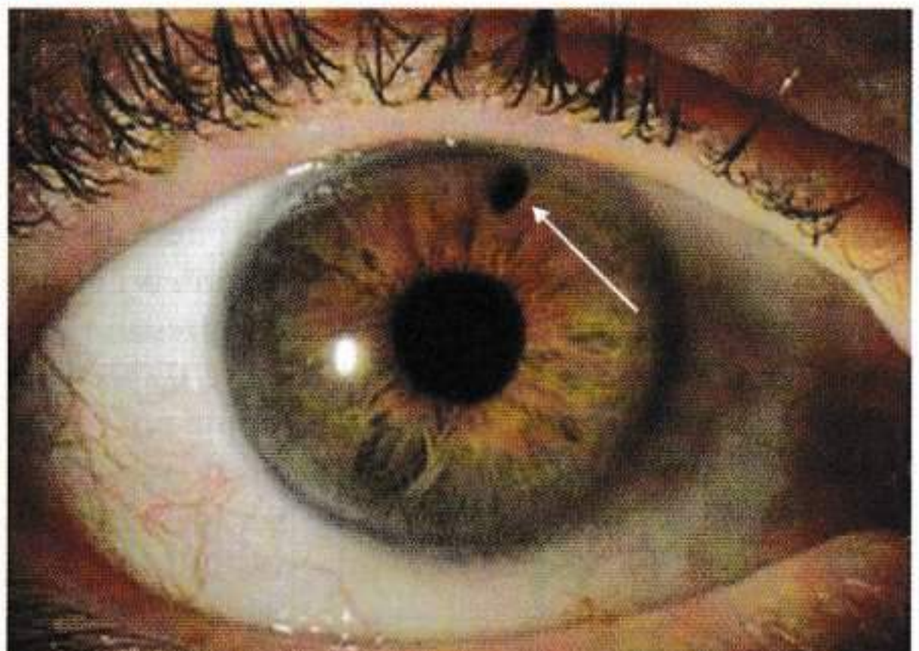


Image 7

19. **Which procedure has been performed for the patient in the image?**
    a. Laser Trabeculoplasty
    b. Laser peripheral Iridoplasty
    c. Laser Iridotomy
    d. Iris Sphincterotomy

20. **Which laser unit is most commonly used for the procedure?**
    a. Argon
    b. Frequency doubled Nd:YAG
    c. Nd:YLF
    d. Pulsed Nd:YAG

21. **All of the following are administered pre-operatively to the patient (for the procedure in the image), except**
    a. Topical timolol
    b. Topical steroids
    c. Topical apraclonidine
    d. Topical pilocarpine

Question number 22 is based on Image 8.

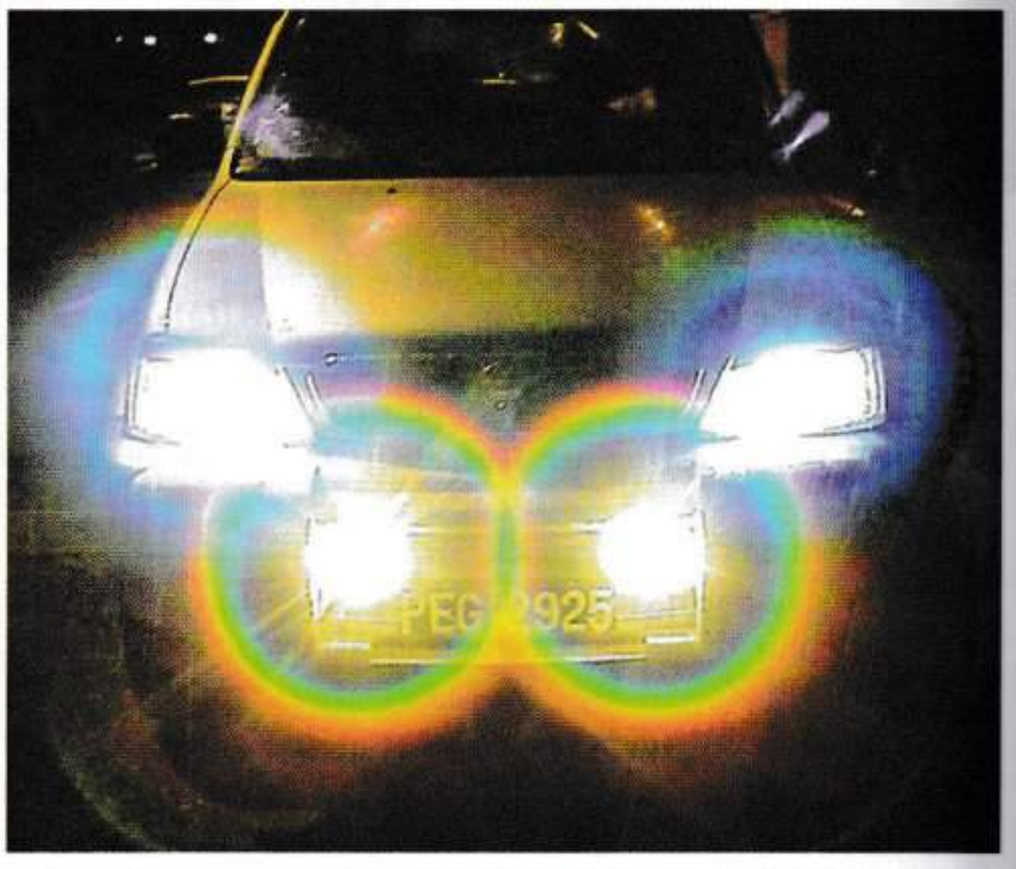


Image 8

22. **40 year old male patient complaints of (shown in image). Which of the following is the least likely cause?**
    a. Angle closure glaucoma
    b. Acute anterior uveitis
    c. Tetracycline eye ointment
    d. Central cataract

Question numbers 23 and 25 are based on Image 9.

Image 9

Most Recent Image-based Questions of 2019-2017 are given at the end

23. **This 60 year old woman complains of several episodes of sharp pain in her right eye over the past few months. Her visual acuity was normal in both eyes and her IOP was elevated. The above picture is of her right anterior segment. What is seen in the picture?**
    a. Corneal edema
    b. Aqueous cells
    c. Posterior synechiae
    d. Glaukomflecken
24. **Other signs that may be present in a patient with the above anterior segment photograph are all except**
    a. Sampaolesi line
    b. Shallow anterior chamber
    c. Sector atrophy of the iris
    d. Peripheral anterior synechiae
25. **A patient presented with sudden onset eye pain and vomiting. On examination the above image is seen with shallow anterior chamber. What is the most likely diagnosis?** ***(Recent pattern 2013)***
    a. Acute iridocyclitis
    b. Acute Angle closure glaucoma
    c. Acute Conjunctivitis
    d. Acute scleritis

Question numbers 26 and 27 are based on Image 10.

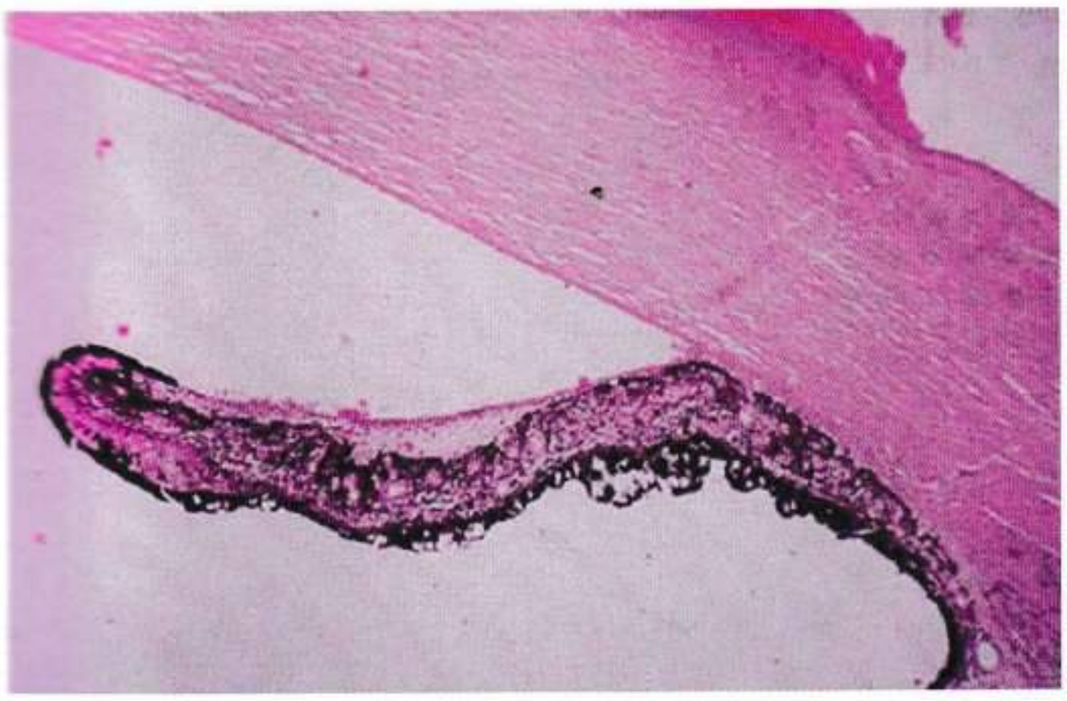


Image 10

26. **The patient 62 year old male, has a history of diabetes and hypertension for past 10 years. He complains of gradual painless loss of vision and pain in the right eye. The histology of anterior segment is as shown in the image. What is the most likely diagnosis?**
    a. 100 day glaucoma
    b. Neovascular glaucoma
    c. Pupillary block glaucoma
    d. Iridoschisis
27. **All of the following abnormalities are seen in the above specimen image except:**
    a. Peripheral anterior synechiae
    b. Ectrpion uveae
    c. Corneal endothelial dystrophy
    d. Rubeosis iridis

Question number 28 is based on Image 11.

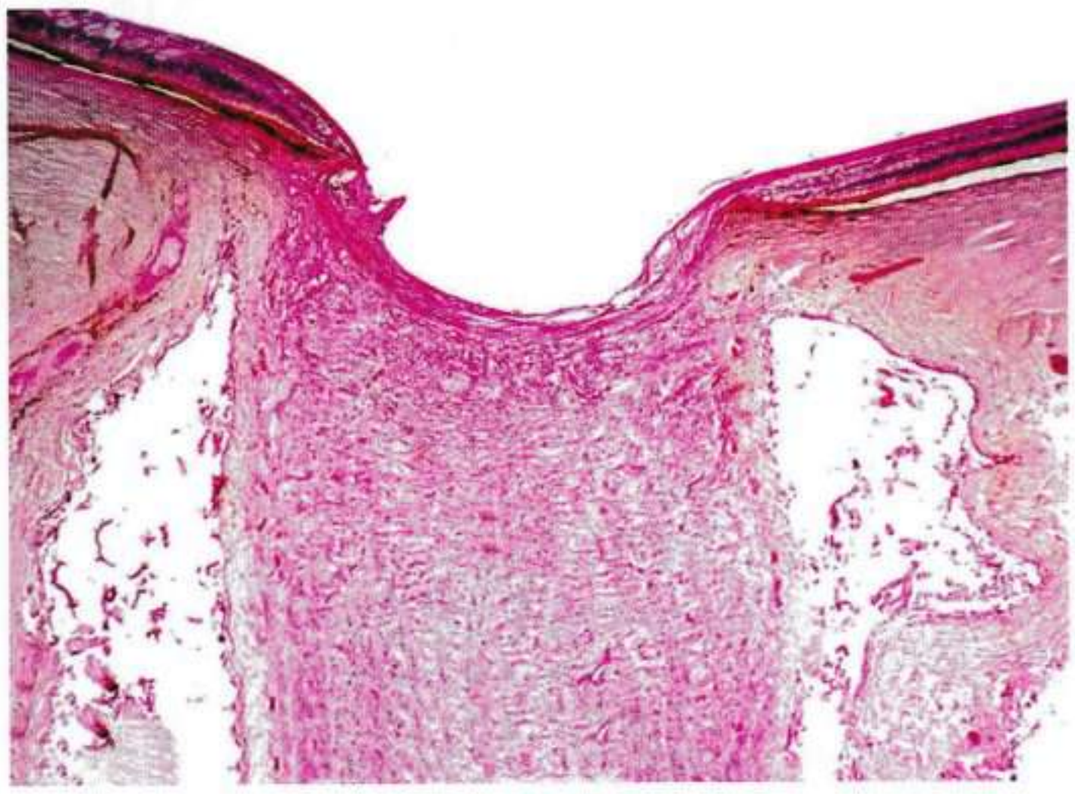


Image 11

28. **Identify the pathology:**
    a. Leber hereditary optic neuropathy
    b. Secondary optic atrophy
    c. Drusen
    d. Glaucomatous optic atrophy

Most Recent Image-based Questions of 2019-2017 are given at the end

Question numbers 29 and 30 are based on Image 12.

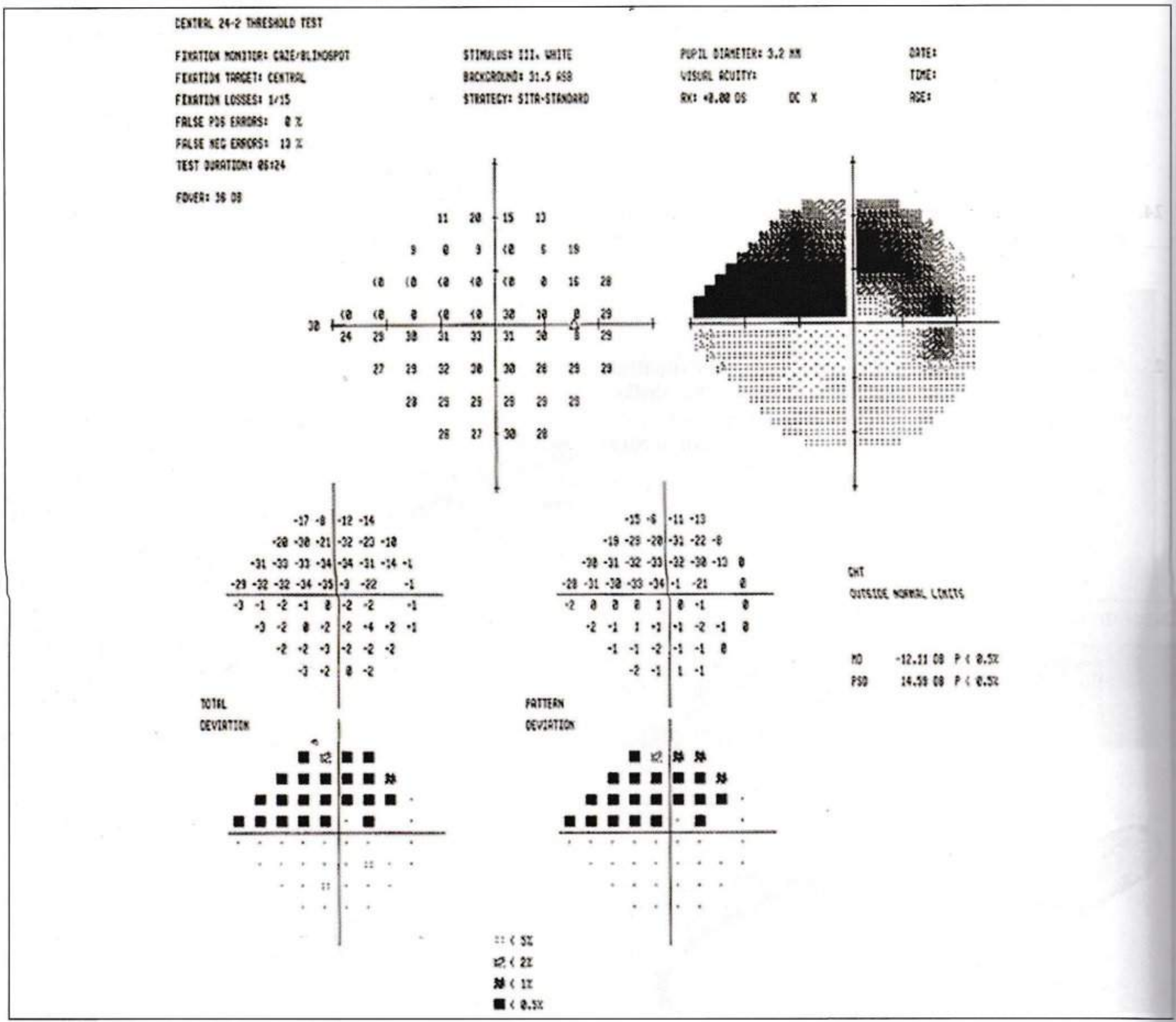


Image 12

29. **The image given relates to which investigation?**
    a. Perimtery
    b. Gonioscopy
    c. Electroretinography
    d. Scanning laser polarimetry
30. **Based on the perimtery result print-out, what is the most likely diagnosis?**
    a. Retinitis pigmentosa
    b. Open angle glaucoma
    c. Pituitary adenoma
    d. Temporal lobe infarct

Question number 31 is based on Image 13.

Image 13

Most Recent Image-based Questions of 2019-2017 are given at the end

31. **Patient gives a long history of gradual slowly progressive dimunition of vision which is now associated with severe pain in his right eye. On examination the anterior segment is seen as in the image and the IOP is measured to be 58 mmHg. What is the most likely diagnosis?**
   a. Glaukomflecken
   b. Phacolytic glaucoma
   c. Phacomorphic glaucoma
   d. Malignant glaucoma

32. **Clinical presentation of a 26 year old myopic male with raised IOP is given below. Which of the following is the most likely diagnosis?**
   a. Pseudoexfoliation syndrome
   b. Phacolytic glaucoma
   c. Pigmentary glaucoma
   d. Acute anterior uveitis

Most Recent Image-Based Questions of 2019-2017

Question number 32 is based on Image 14.

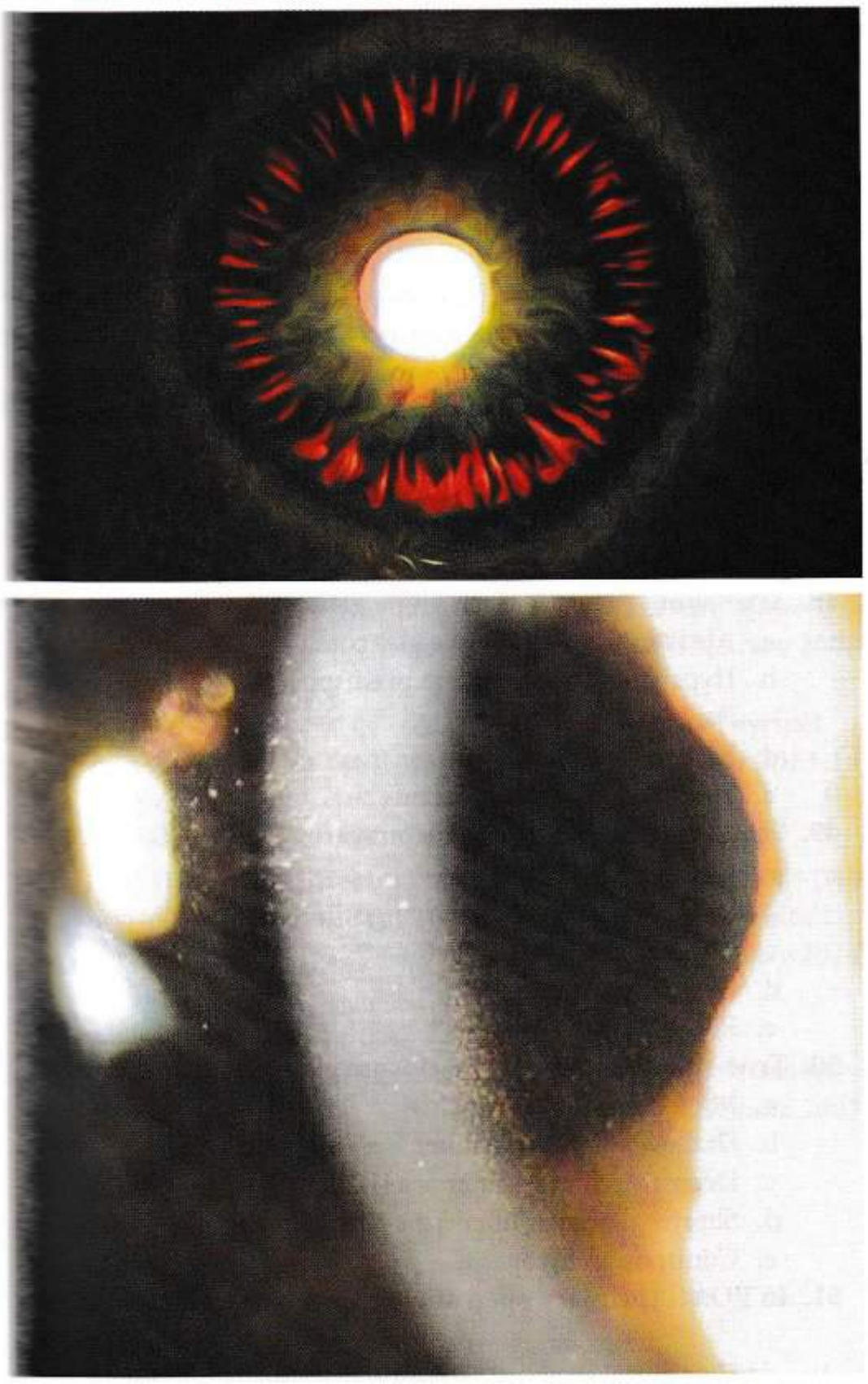


Image 14

Question number 33 is based on Image 15.

Image 15

33. **A 2-year-old child comes to the OPD presents with photophobia, what is the most likely diagnosis?** ***(AIIMS Nov 2018)***
   a. Congenital glaucoma
   b. Retinoblastoma
   c. Congenital endothelial dystrophy
   d. Megalocornea

Most Recent Image-based Questions of 2019-2017 are given at the end

Investigations

34. The critical angle of cornea-air interface is: *(AIIMS May 2014)*

a. 36° b. 46°
c. 56° d. 66°

35. Which of the following procedures does not need dilatation of the pupil? *(AIIMS May 2014)*

a. Laser inferometry b. Retionoscopy
c. Fundus examination d. Gonioscopy

36. Tonometry with variation in applanation surface is: *(AIIMS Nov 2012)*

a. Maklakov tonometer
b. Draeger tonometer
c. Rebound tonometer
d. MacKay-Marg tonometer

37. Imbert fick law is used for which of the following type of tonometry *(Recent pattern Nov/Dec 2016)*

a. Applanation Tonometry
b. Indentation Tonometry
c. Dynamic contour tonometry
d. Rebound Tonometry

38. Tonography helps you to determine:

a. The facility of outflow of aqueous
b. Diurnal variation
c. The levels of intraocular pressure at different times
d. None of the above

39. Which examination is of least value in open angle glaucoma?

a. Tonometry
b. Perimetry
c. Indirect ophthalmoscopy
d. Direct ophthalmoscopy

40. Campimetry measures:

a. Field of vision b. Acuity of vision
c. Colour vision d. Includes all

41. Van Herick angle grade '3' of anterior chamber denotes- *(Recent pattern Nov/Dec 2016)*

a. Wide open angle
b. Moderately open angle
c. Moderately narrow angle
d. Closed angle

42. Gold standard in measuring intraocular pressure is

a. Schiøtz tonometer b. Applanation tonometer
c. Air puff tonometer d. Pulsair tonometer

43. Tonometry used in a patient with irregular surface of cornea *(AIIMS May 2012)*

a. Maklakow tonometer
b. Draeger tonometer
c. Rebound tonometer
d. Mackay-Marg tonometer

44. A lady presented with reddish eye and watering over left eye with a shallow anterior chamber. What is the next best investigation? *(Recent pattern Nov/Dec 2016)*

a. Tonometry b. Cup disc ratio
c. Gonioscopy d. Ophthalmoscopy

45. Humphrey field analyser is a type of

a. Manual static perimeter *(Recent pattern Nov/Dec 2016)*
b. Automated Static Perimeter
c. Manual Kinetic Perimeter
d. Automated Kinetic perimeter

46. You have been referred a middle-aged patient to rule out open angle glaucoma. Which of the following findings will help in the diagnosis? *(AIIMS Nov 2009)*

a. Cupping of the disc
b. Depth of anterior chamber
c. Visual acuity and refractive error
d. Angle of the anterior chamber

Primary Open Angle Glaucoma

47. A 75 year old patient presents with deterioration of vision. On examination the pupillary reflex is observed to be sluggish and the intraocular pressure is normal. Optic disc evaluation shows a large and deep cup and paracentral scotomas. The most likely diagnosis is: *(All India 2012)*

a. Primary Narrow angle glaucoma
b. Normal Tension Glaucoma
c. Neovascular Glaucoma
d. Absolute Glaucoma

48. True about primary open angle glaucoma: *(PGI May 2016)*

a. Also k/a Chronic simple glaucoma
b. Hypermetropes are more predisposed
c. Polygenic inheritance
d. Laser iridotomy is used for treatment
e. Fundus examination reveals large cup

49. Features of open angle glaucoma are: *(PGI Nov 2011)*

a. Common in Asian
b. Small diurnal pressure change
c. Thin cornea is a risk factor
d. Optic disc changes
e. Raised IOP

50. True about primary angle closure glaucoma *(PGI Nov 2010)*

a. More common in females
b. Shallow anterior chamber is a risk factor
c. Deep anterior chamber is a risk factor
d. Shorter diameter of cornea is a predisposing factor
e. Common in myopes

51. In POAG (primary open angle glaucoma) which is not seen *(PGI Dec 2006)*

a. Horizontal cupping b. Bayonetting sign
c. Macular edema d. Dot sign
e. Seidel's scotoma

52. Frequent change of presbyopic glass is a feature of- *(Recent pattern Nov/Dec 2016)*

a. Senile cataract b. Retinal detachment
c. Intumescent cataract d. Open angle glaucoma

53. Earliest visual field defect in open angle glaucoma is- *(AIIMS, UP 2008)*

a. Contraction of isopters b. Enlarged blind spot
c. Nasal step d. Arcuate scotoma

Most Recent Questions of 2019-2017 are given at the end

54. **On mutation, which of the following may give rise to hereditary glaucoma?** *(AIIMS May 03)*
   a. Optineurin b. Ephrins
   c. RBA8 d. Huntingtin

55. **Ex-Press glaucoma shunt is made up of:** *(AIIMS May 2014)*
   a. Titanium b. Gold
   c. Silicon d. Stainless steel

Primary Angle Closure Glaucoma

56. **Glaucomflecken is a feature of?** *(Recent pattern Nov/Dec 2016)*
   a. Acute angle-closure glaucoma
   b. Pigmentary glaucoma
   c. Primary open angle glaucoma
   d. Congenital glaucoma

57. **Glaucomflecken is** *(Recent pattern 2012-13)*
   a. Acute uvetis due to glaucoma
   b. Lens opacity due to glaucoma
   c. Retinal detachment due to glaucoma
   d. Corneal opacity due to glaucoma

58. **Cause(s) of shallow anterior chamber is/are:**
   a. Anterior subluxation of lens *(PGI May 2014)*
   b. Pupil block due to vitreous bulge after ICCE
   c. Anterior dislocation of lens in anterior chamber
   d. Aphakia
   e. Myopia

59. **All of the following predispose to angle closure glaucoma, except** *(Recent pattern 2016, AIIMS Nov 2000)*
   a. Small cornea b. Flat cornea
   c. Shallow AC d. Short axial length of eyeball

60. **Type of laser used for iridotomy** *(AI 2013-14)*
   a. Excimer b. Krypton red
   c. Nd: YAG d. Diode

61. **A 36 years old female on prone dark room test develops pain in eyes. Which of the following drops should be avoided?** *(AIIMS May 2014)*
   a. Pilocarpine b. Atropine
   c. Timolol d. Acetazolamide

62. **Which of the following is not a feature of acute congestive glaucoma-** *(PGI June 2005)*
   a. Deep angle
   b. Painful condition
   c. Vertically oval pupil
   d. Increased intraocular pressure
   e. Nonreactive pupil

63. **Not a symptom of angle closure glaucoma-** *(Recent pattern Nov/Dec 2016)*
   a. Blurring of vision b. Coloured Halos
   c. Metamorphopsia d. Headache

64. **In acute congestive glaucoma, pupil is** *(Recent pattern, PGI June 1997)*
   a. Oval and horizontal b. Oval and vertical
   c. Circular d. Slit like

65. **Drug of choice for acute congestive glaucoma is** *(AIIMS Dec 1999, 1994; AI 1996)*
   a. 1-2% pilocarpine b. Timolol
   c. Levobunanol d. Atropine

66. **A 68-year-old female patient is seen on the ward. She complains of severe pain in her right eye. There is blurring of vision and she feels nauseated and has vomited several times. Earlier in the day she has undergone colonoscopy for evaluation of her long-standing Crohn's disease. The endoscopist has made a comment that the examination was difficult. What is the likely cause of her painful red eye?**
   a. Anterior uveitis b. Acute conjunctivitis
   c. Episcleritis d. Acute angle closure glaucoma

Treatment

67. **Which of the following anti-glaucoma medications can cause drowsiness?** *(All India 2006)*
   a. Latanoprost b. Timolol
   c. Brimonidine d. Dorzolamide

68. **Which of the following drugs is not used topically for treatment of open angle glaucoma:** *(All India 2006)*
   a. Latanoprost b. Brimonidine
   c. Acetazolamide d. Dorzolamide

69. **Orally used drug for Glaucoma is?** *(Recent pattern 2014)*
   a. Acetazolamide b. Brimonidine
   c. Latanoprost d. Betaxolol

70. **Which of the following drugs should not be given in a patient of narrow angle glaucoma?** *(AIIMS May 2014)*
   a. Homatropine b. Phenylephrine
   c. Timolol d. Acetazolamide

71. **Which of the following pairs of drugs is correctly matched with its mechanism of action?** *(AIIMS May 2013)*
   a. Pilocarpine-increased uveoscleral outflow
   b. Latanoprost-decreased aqueous secretion
   c. Brimonidine-decreased aqueous formation
   d. Betaxolol –increased trabecular outflow

72. **In a case of hypertensive uveitis, most useful drug to reduce intraocular pressure is:**
   a. Pilocarpine b. Latanoprost
   c. Physostigmine d. Dipivefrine

73. **Pilocarpine is not used in young adults as it causes:**
   a. Retinal detachment
   b. Myopia
   c. Iris cysts
   d. Shallow anterior chamber

74. **Which of the following causes least increase in IOP?**
   a. Flouromethalone b. Triamicinolone
   c. Dexamethasone d. Hydrocortisone

75. **Acquired nasolacrimal duct obstruction is a side effect of therapy of which of the following medications?** *(AIIMS Nov 2010)*
   a. Timolol b. Brimonidine
   c. Dorzolamide d. Pilocarpine

76. **Which of the following topical agents cause heterochromia iridis?** *(Recent pattern 2014)*
   a. Latanoprost b. Prednisolone
   c. Timolol d. Olopatadine

Most Recent Questions of 2019-2017 are given at the end

77. **Which of the following drugs acting on dilator pupillae has an action analogous to that of pilocarpine on sphincter pupillae?** *(AIIMS May 2016)*
   a. Timolol b. Phenylephrine
   c. Neostigmine d. Tropicamide

78. **A patient having glaucoma develops blepharoconjunctivitis after instilling some antiglaucoma drug. Which of the following drug can be responsible for it?** *(Recent pattern 2012)*
   a. Timolol b. Latanosprost
   c. Dipiverine d. Pilocarpine

79. **Following are the side effects of apraclonidine except** *(Recent pattern 2015)*
   a. Lid dermatitis b. Follicular conjunctivitis
   c. Eye lid retraction d. Watering of mouth

80. **Which of the following is not used in glaucoma in a hypertensive patients** *(AIIMS Nov 2000)*
   a. Dipiverfrine b. β-blockers
   c. Alpha agonist d. Trabeculoplasty

81. **Contraction of visual field is seen with which anticonvulsant** *(AIIMS Nov 2015)*
   a. Ethosuxamide b. Phenobarbitone
   c. Valproate d. Vigabatrin

82. **Latanoprost used topically in glaucoma primarily acts by**
   a. Decreasing aqueous humour formation *(AI 2004)*
   b. Increasing uveoscleral outflow
   c. Releasing pupillary block
   d. Increasing trabecular outflow

83. **Angle closure glaucoma can be precipitated by** *(Recent pattern 2015)*
   a. Phenytoin b. Topiramate
   c. Valproate d. Carbamezapine

84. **Cholinergic drugs like pilocarpine are routinely used to treat glaucoma. What is their mechanism of action in eye that accounts for this ophthalmologic use?**
   a. Reduction in formation of aqueous humour
   b. Blockade of adrenergic receptors
   c. Alkalinization of aqueous humour
   d. Improved drainage of aqueous humour

85. **All of the following conditions are contraindicated or likely to worsen in a case of primary open angle glaucoma, when treated with Timolol maleate 0.5% eye drops, except** *(AIIMS May 2008)*
   a. Hypertension b. Hypercholesterolemia
   c. Depression d. Bronchial asthma

Congenital Glaucoma

86. **Haab's striae are seen in?** *(Recent pattern 2013)*
   a. Trachoma b. Congenital glaucoma
   c. Scleritis d. Cataract

87. **A child presents with lid lag and an enlarged cornea with a diameter of 13 mm. Examination of the eye reveals double contoured opacities concentric to the limbus. Which of the following is the most likely diagnosis?** *(All India 2012)*
   a. Superficial keratitis
   b. Deep keratitis
   c. Thyroid Endocrinopathy
   d. Congenital Glaucoma

88. **Feature (s) of Infantile glaucoma is/are except:**
   a. Aniridia may be associated *(PGI Nov 2014)*
   b. Treatment includes trabeculotomy
   c. Buphthalmos can occur
   d. Cornea is thin & clear
   e. May be associated with Sturge-weber syndrome

89. **A 30-day-old neonate was presented with a history of photophobia and excessive lacrimation. On examination, both the lacrimal duct systems are normal, but there was a large cornea with haziness. The diagnosis is:**
   a. Megalocornea b. Keratoconus
   c. Congenital glaucoma d. Hunter's syndrome

90. **Most common symptom in buphthalmos is** *(Recent pattern 2013)*
   a. Lacrimation b. Pain
   c. Photophobia d. Itching

91. **The treatment of choice for congenital glaucoma is** *(AIIMS May 2003, Recent pattern 2015)*
   a. Topical medications
   b. Trabeculoplasty
   c. Trabeculotomy with trabeculectomy
   d. Goniotomy

92. **Von Recklinghausen disease is associated with:**
   a. Glaucoma *(All India 2008)*
   b. Optic nerve glioma
   c. Neurofibroma of the lids
   d. All the above

93. **Barkan membrane is seen in which of the following conditions** *(Recent pattern 2015)*
   a. Anterior uvieits
   b. Congenital glaucoma
   c. Primary open angle glaucoma
   d. Shallow anterior chamber

Secondary Glaucoma(s) and Miscellaneous

94. **False statement about depth of anterior chamber**
   a. Less in women than men *(PGI Nov 2010)*
   b. Correspondent to volume of anterior chamber
   c. Increase with age
   d. More in myopes
   e. Less in hypermetropes

95. **What is the depth of the anterior chamber?** *(Recent pattern Dec 2015)*
   a. 2.5 to 3.5 mm b. 3.5 mm to 4.5 mm
   c. 4.5 mm to 5.5 mm d. 5.5 mm to 6.5 mm

96. **Cells most commonly affected in glaucomatous optic atrophy** *(AIIMS May 2014)*
   a. Ganglion cells
   b. Rods and cones
   c. Bipolar cells
   d. Amacrine cells

97. **True about pigmentary glaucoma :** *(PGI May 2014)*
   a. More common in females
   b. More common in myopes
   c. Slit-like transillumination defects in the mid periphery is pathognomonic feature
   d. Occur due to clogging up of the trabecular meshwork

Most Recent Questions of 2019-2017 are given at the end

98. **Increased intraocular tension is seen in all except:**
   a. Epidemic dropsy
   b. Branch retinal vein occlusion
   c. Malignant melanoma
   d. Phthisis bulbi

99. **Irido Corneal Endothelial syndrome is characterized by** *(AIIMS, May 2008)*
   a. Bilateral, symmetrical corneal stromal edema
   b. Deposition of abnormal collagen in Descemet's membrane
   c. Deposition of glycosaminoglycans in the Descemet's membrane
   d. Progressive atrophy of iris atrophy

100. **Triple surgery in glaucoma includes all of the following except–** *(Recent pattern 2016)*
   a. Trabeculectomy
   b. PCIOL implantation
   c. Insertion of drainage device
   d. Extra capsular cataract extraction

101. **A male patient with a history of hypermature cataract presents with a 2 day history of ciliary congestion, photophobia, blurring of vision and on examination has a deep anterior chamber in the right eye. The left eye is normal. The diagnosis is** *(AIIMS May 2001)*
   a. Phakomorphic glaucoma
   b. Phakolytic glaucoma
   c. Phakotoxic glaucoma
   d. Phakoanaphylactic uveitis

102. **Malignant glaucoma is seen in** *(NIMHANS 2015)*
   a. Malignancy
   b. After surgery for cataract or glaucoma
   c. Trauma
   d. Thrombosis

103. **Mechanism of steroid induced glaucoma is** *(Recent pattern 2014)*
   a. Narrowing of angle of anterior chamber
   b. Neovascularization of Iris
   c. Inhibition of PGE
   d. Deposition of hemosiderin

104. **Krukenberg spindle** *(Recent pattern 2013)*
   a. Involves anterior surface of cornea
   b. Involves anterior lens surface
   c. Involves posterior surface of cornea
   d. Involves posterior surface of lens

105. **Which of the following may be seen in Pigmentary glaucoma** *(Recent Question)*
   a. Ferry line b. Fleischer's line
   c. Hudson-Stahli line d. Krukenberg's spindle

106. **Hypersecretory glaucoma is seen in** *(Recent pattern 2014)*
   a. Epidemic dropsy b. Marfan's syndrome
   c. Hypertension d. Diabetes

107. **Treatment option for glaucoma includes all except** *(PGI June 2008)*
   a. Trabeculectomy b. Trabeculotomy
   c. Vitrectomy d. Viscocanalostomy
   e. Iridectomy

108. **The major mechanism of aqueous humor formation is:** *(All India 2007)*
   a. Active secretion b. Ultrafiltration
   c. Diffusion d. Osmosis

Most Recent Questions of 2019-2017

109. **In glaucoma last field to be affected:** *(Recent pattern 2017)*
   a. Nasal
   b. Temporal
   c. Central
   d. Superior

110. **All of the following are seen in Iridocorneal endothelial syndrome except** *(PGI May 2018)*
   a. Cataract
   b. Corectopia
   c. Iris cysts
   d. Iris atrophy

111. **Which of the ocular lesion is seen in Sturge Weber Syndrome?** *(AIIMS Nov 2018)*
   a. Retinitis pigmentosa
   b. Glaucoma
   c. Keratitis
   d. Uveitis

112. **A patient with diabetic macular edema develops glaucoma. Which antiglaucoma drug is least preferred in this patient?** *(AIIMS Nov 2018)*
   a. Alpha agonist b. Prostaglandin analogues
   c. Pilocarpine d. Beta blockers

113. **Pilocarpine eye drops act as** *(Recent question June 2018)*
   a. Directly acting mydriatic
   b. Directly acting miotic
   c. Indirectly acting miotic
   d. Indirectly acting mydriatic

114. **Neovascularization of iris is frequently seen in all/except** *(Recent question June 2018)*
   a. CRVO
   b. Diabetic retinopathy
   c. Fuch's heterochromic cyclitis
   d. Congenital cataract

115. **Glaucoma valve implant is used in which of the following surgery?** *(Recent question Jan 2019)*
   a. Trabeculectomy
   b. Sclerotomy
   c. Laser photocoagulation
   d. Setons

116. **Which anti glaucoma drug causes apnea in children?** *(Recent question Jan 2019)*
   a. Beta blockers
   b. Cholinergics
   c. Alpha 2 adrenergic agonists
   d. Carbonic anhydrase inhibitors

117. **Intravenous (I.V.) Mannitol is used in which of the following conditions** *(Recent question Jan 2019)*
   a. CRAO
   b. Congestive heart Failure
   c. Angle closure glaucoma
   d. Pulmonary edema

118. **A patient came to the casualty with acute attack of asthma after starting treatment of glaucoma. The causative drug is** *(Recent question Jan 2019)*
   a. Timolol
   b. Betaxolol
   c. Clonidine
   d. Acetazolamide

Most Recent Questions of 2019-2017 are given at the end

ANSWERS TO IMAGE-BASED QUESTIONS

1. Ans. (c) Indentation tonometry

Ref: Parson's 22/e. p. 126

The instrument in the image is a Schiotz tonometer – which is based on principle of Indentation tonometry – a plunger will indent and thus displace aqueous to raise IOP more in a soft eye than a hard eye.

2. Ans. (d) If the scale reading is less than 4 with a starting weight of 5.5 g, additional weight is added

Ref: Shields 6/e, p. 29; Khurana anatomy 2/e, p. 76-77

Option a – fact

Option b – whenever the tonometer is brought near to the eye, there is a tendency to accommodate. The contraction of ciliary muscle **in accommodation** increases the facility of aqueous outflow by pulling on the trabeculae and thus, causes **lowering of the IOP**.

Opposite effect on **IOP (increase)** is seen due to reflex **contraction of extraocular muscles**.

Option c – by indentation, the instrument artificially raises the IOP from P(o) to P(t). The scale reading of the tonometer actually measures the artificially raised IOP.

IOP with instrument P(t) = Actual IOP P(o)
+Scleral rigidity (K)

Thus, conversion tables are needed to determine P(o) which were developed by Friedenwald in 1948 and 1955.

Option d – It is customary to start with 5.5 g weight, and additional weight (7.5, 10, 15 g) is added if the reading is lesser than 3.

3. Ans. (d) Ectropion uveae

Ref: Shields 6/e, p. 264

Option a – Presence of 2 or more pupils in the eye is known as **Polycoria**.

Option b – Displacement of pupil from its normal position is known as **corectopia**.

Option c – Stretch iris atrophy leading to hole formation in the iris.

Option d – Ectropion uveae – eversion of the posterior pigmented epithelium of iris at the pupillary margin.

4. Ans. (c) ICE syndrome

Ref: Shields 6/e, p. 262-270

	ICE syndrome	PPMD	Axenfeld-Rieger	Aniridia
Involvement	**Unilateral**	Bilateral	Bilateral	Bilateral
Inheritance	Sporadic	AD	AD	AD/sporadic (PAX gene defect)
Age	**20–50 years/ Women**		Congenital (presents at **young age**)	Congenital
Endothelial changes	(+)	(+)	(–)	(–)
Iris changes	(+)	(+)	(+)	(+)

On specular microscopy

ICE syndrome	PPMD
Endothelial cells appear as dark areas with central highlights and dark peripheral borders	Shows vesicles and bands

5. Ans. (b) The primary pathologic change occurs in the corneal epithelium

Ref: Shields 6/e, p. 262-264

ICE Syndrome (Irido-corneal Endothelial)

Option a – Glaucoma occurs most commonly in Progressive iris atrophy

- **Angle closure** due to peripheral anterior synechiae
- Open angle **due to retrocorneal membrane** covering the trabecular meshwork

Option b – ICE syndrome is characterized by a *primary corneal endothelial abnormality*, giving rise to a 'Fine Hammered silver' or 'Beaten silver' appearance.

Option c – Retrocorneal membrane seen over the anterior chamber angle and the anterior surface of iris, which causes glaucoma.

Option d – Laser trabeculoplasty is not effective (Glaucoma is more commonly angle closure, though in some cases, open angle glaucoma can also occur).

In early stages, the glaucoma can be controlled medically. Filtering surgery is reasonably successful.

6. Ans. (d) Hypermetropia

As can be seen from the characteristic appearance of the eyes – BLUE EYES (hypnotize – YO YO), it is a case of Buphthalmos – **Primary congenital glaucoma.**

Option a – Astigmatism due to Haab's Striae

Option b – Myopia occurs due to enlargement of globe (Increase in axial length)

Option c – Amblyopia due to anisometropia or astigmatism in one eye

7. Ans. (b) Trabeculotomy

Ref: Parson's 22/e, p. 305

- Goniotomy: Treatment of choice, if, cornea is clear.
- Trabeculotomy: also can be done in presence of corneal opacification.
- Trabeculectomy and Trabeculotomy: Overall Treatment of choice.

Though all the procedures have staunch supporters, T&T is preferred because fewer repeated procedures are required.

8. Ans. (d > c) (d) >13 mm better than (c) >12 mm

Ref: Shields 6/e, p. 211

Option a, b – The healthy newborn's cornea has a horizontal diameter ranging from 9.5 mm to 10.5 mm, and enlarges about 0.5 mm to 1 mm in the 1st year of life.

Option c – A corneal diameter >12 mm in the first year of life is a **highly suspect** finding for Buphthalmos.

Option d – Corneal diameter >13 mm at any age **strongly suggests abnormality**.

9. Ans. (a) Tonometry

Ref. Kanski's 8/e, p. 307- 308

10. Ans. (d) Cornea is stained with Rose Bengal

Ref: Parson's 22/e, p. 127

Option a – Goldmann based his concept on the Imbert-Fick law, which states that an external force (W) against a sphere equals the pressure in the sphere (P_t) multiplied by the area flattened by the external force (A).

Option b – The area to be applanated remains constant, and this measures the force required to applanate that area, thus Variable force Tonometry.

Option c – A fact circular plexiglass plate 7 mm in area is applied, to flatten 3.06 mm diameter of the posterior corneal surface.

Option d – Cornea after being anesthetized is stained with Sodium fluorescein.

11. Ans. (c) False low IOP

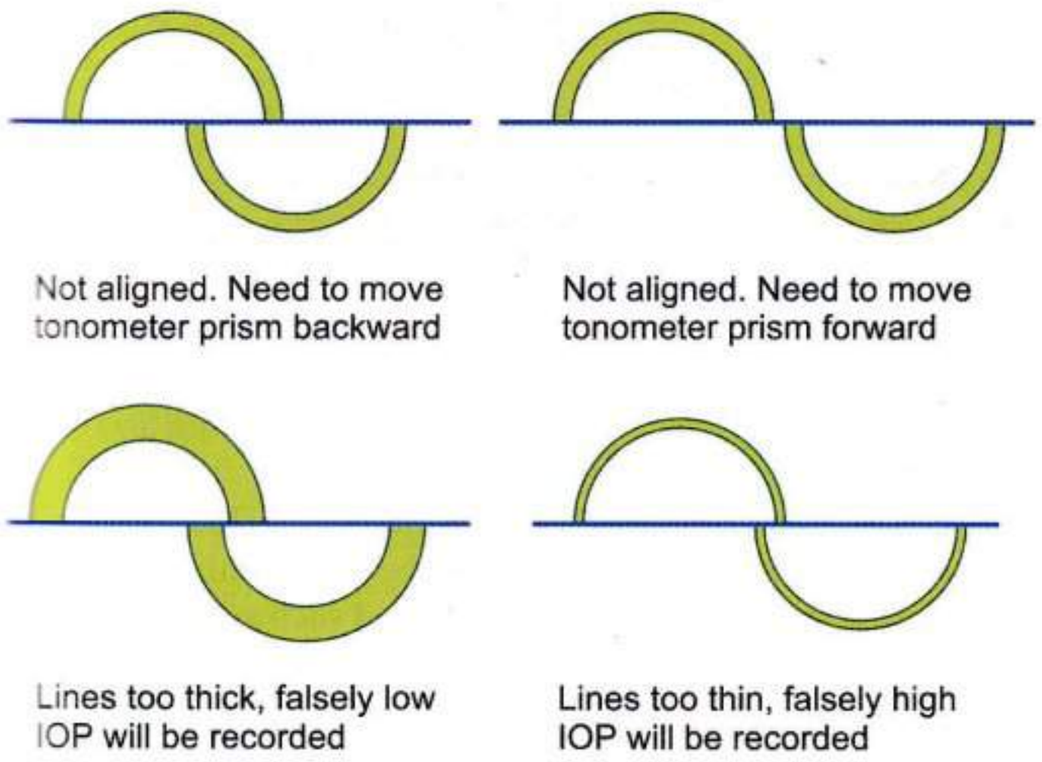
Ref: Shields 6/e, p. 30-31

In GAT, for every 10 micron change in the corneal thickness the IOP changes by 1 mm Hg.

Thus after LASIK surgery for myopia where the cornea is ablated and the corneal thickness is decreased, the measured IOP would also be low. Thus, False low IOP in thin cornea.

12. Ans. (c)

Ref: Parson's 22/e, p. 127-128


Not aligned. Need to move tonometer prism backward
Not aligned. Need to move tonometer prism forward
Lines too thick, falsely low IOP will be recorded
Lines too thin, falsely high IOP will be recorded

Incorrect alignment of AT rings – Incorrect IOP recorded
At the correct endpoint – Inner margins of both rings should be touching each other

13. Ans. (c) Bjerrum scotoma

Ref: Khurana 6/e, p. 234

The above image is of Perimetry charting showing a complete arcuate scotoma or a Bjerrum Scotoma.

Bjerrum/Arcuate Scotoma – scotoma of the entire arcuate area from the blind spot to the median raphe, corresponding to the arcuate retinal nerve fibers.

14. Ans. (b) Primary open angle glaucoma

The patient has Normal Pupil, Deep anterior chamber, High IOP (>21 mm Hg, important risk factor), Cupping of the disc (c:d ratio > 0.5) with Bjerrum scotoma.

Option a – only IOP rise, no optic disc changes seen.

Option b – Characteristic optic disc changes with irreversible VF changes, accompanied by an open angle indicated by a deep anterior chamber, with high IOP.

Option c – PXG presents with characteristic corneal (flecks on corneal endothelium), iris (Fnocks), and cataract, poor mydriasis along with systemic changes.

Option d – based on the history, there is no identifiable cause for the glaucomatous changes seen.

15. Ans. All

Although the arcuate defect is the most reliable form of glaucomatous field loss, it is not pathognomic and if the field and disc changes do not correlate, additional causes must be considered.

- Chorioretinal lesions
- Optic nerve head lesions
- Anterior optic nerve lesions
- Posterior lesions of the visual pathway

16. Ans. (d) Temporal peripheral vision

Ref: Parson's 22/e, p. 289

The temporal island of vision is the more resistant and may persist long after central vision is lost.

17. Ans. (d) Topical Latanoprost OD

Latanoprost (Prostaglandin analogues) are the drug of choice for Primary open angle glaucoma.

Its effects lasts for 24 hours, allowing a once daily dosing, given in the evening.

18. Ans. (c) To examine the angle of anterior chamber

In the image, all the four angle(s) can be seen – thus indicating Gonioscopy being done in the patient to examine the angle of anterior chamber.

19. Ans. (c) Laser Iridotomy

Ref: Parson's 22/e, p. 299

Hole can be seen in the peripheral iris at 1 o'clock
Done to bypass the pupillary block in Angle closure glaucoma – Laser Iridotomy.

20. Ans. (d) Pulsed Nd:YAG

Ref: Parson's 22/e, p. 299

Done using an Argon laser (less common nowadays) or using pulsed Nd:YAG laser (Most commonly used today).

21. Ans. (a) Topical timolol

Ref: Parson's 22/e, p. 299

Preoperative - Topical pilocarpine - to stretch and thin peripheral iris.

Preoperative - Topical steroids - for 24 -48 hours before laser surgery.

Preoperative - Topical apraclonidine - to reduce risk of postoperative IOP rise.

22. Ans. (b) Acute anterior uveitis

Ref: Khurana 6/e, p. 244

23. Ans. (d) Glaukomflecken

Ref: Parson's 22/e, p. 298

Whitish anterior subcapsular opacities (cataract) in a lacy pattern can be seen in the photograph.

On history, it seems to be a case of chronic angle closure glaucoma with frequent acute attacks leading to sharp pain.

This is a typical appearance of **Glaukomflecken** (cataracta disseminata subepithelias).

Glaukomflecken is caused by pressure necrosis of anterior lens epithelium with adjacent subcapsular cortical degeneration. The opacities tend to diminish gradually and become sparse. As new lens fibers grow in from the equator, they overlie the opacities which sink deeper into the lens but will persist as a permanent sign of pressure necrosis.

24. Ans. (a) Sampaolesi line

Option a – Sampaolesi line is accumulation of pigment along the Schwalbe line. It is one of the earliest signs of Exfoliation/ Pseudoexfoliation syndrome.

Option b – in cases of angle closure glaucoma, the chamber is shallow due to the anterior bowing of the central iris.

Option c – pressure atrophy

Option d – can be seen in chronic cases of angle closure glaucoma. Broad based synechiae, most commonly occurring in the superior quadrant.

25. Ans. (b) Acute Angle closure glaucoma

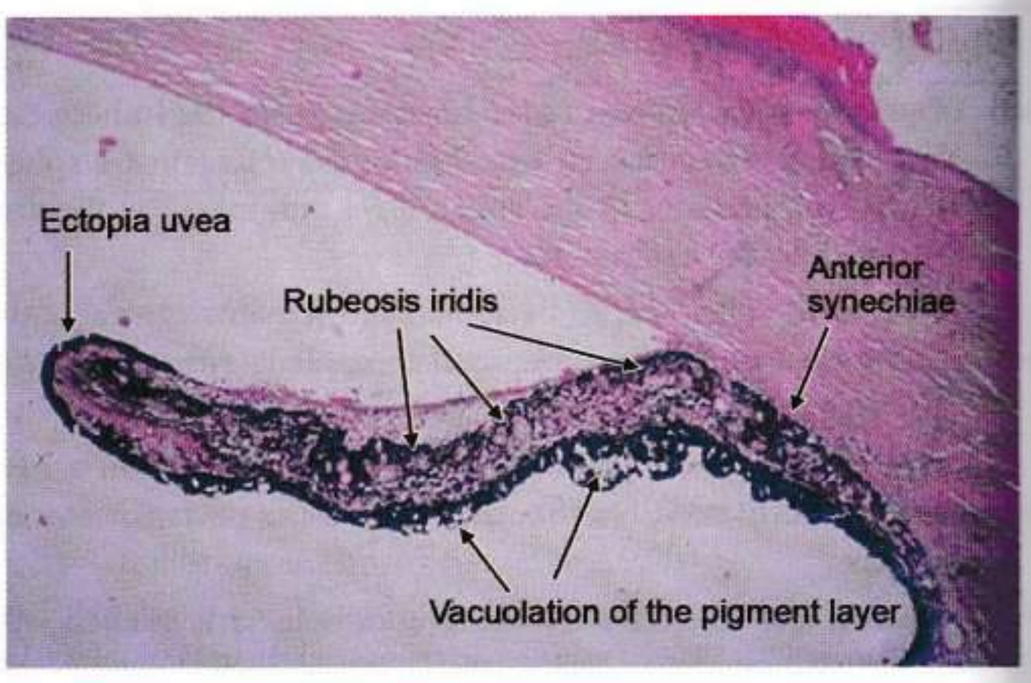
Ref: Shields Glaucoma 6/e, p. 200-201

- In the image, mid-dilated pupil, with corneal haze and lens opacity is seen. These are all signs of acute angle closure glaucoma. Supported by sudden painful onset with vomiting.
- In iridocyditis-pupil is miosed.
- Conjunctivitis doesnot affect pupil or cornea.

26. Ans. (b) Neovascular glaucoma

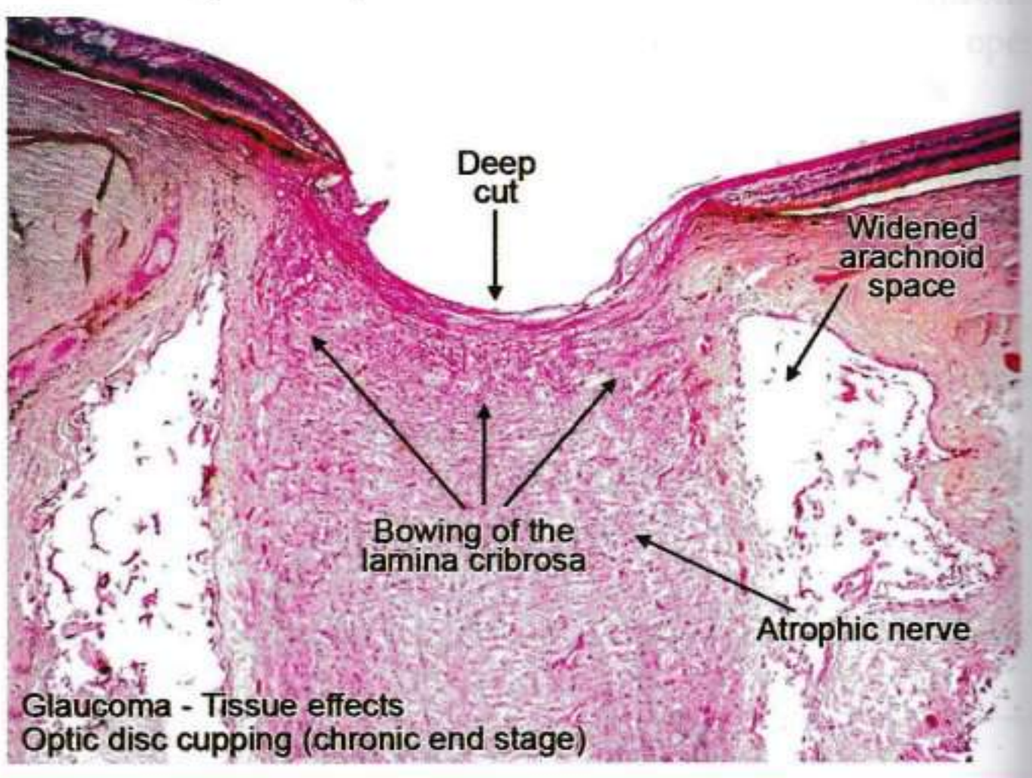
27. Ans. (c) Corneal endothelial dystrophy

- History of DM, old age, complaints of Loss of vision and pain (due to angle closure glaucoma) along with the histological findings of Rubeosis iridis, angle closure due to PAS and pigmented layer seen on the anterior surface of iris (ectropion uveae) confirm this as a case of Neovascular Glaucoma due to Diabetes Mellitus



28. Ans. (d) Glaucomatous optic atrophy

In the H and E section image given, retinal nerve fibre thinning can be noted at the margin of the disc alongwith the Deep cup and the posteriorly bowed lamina cribrosa

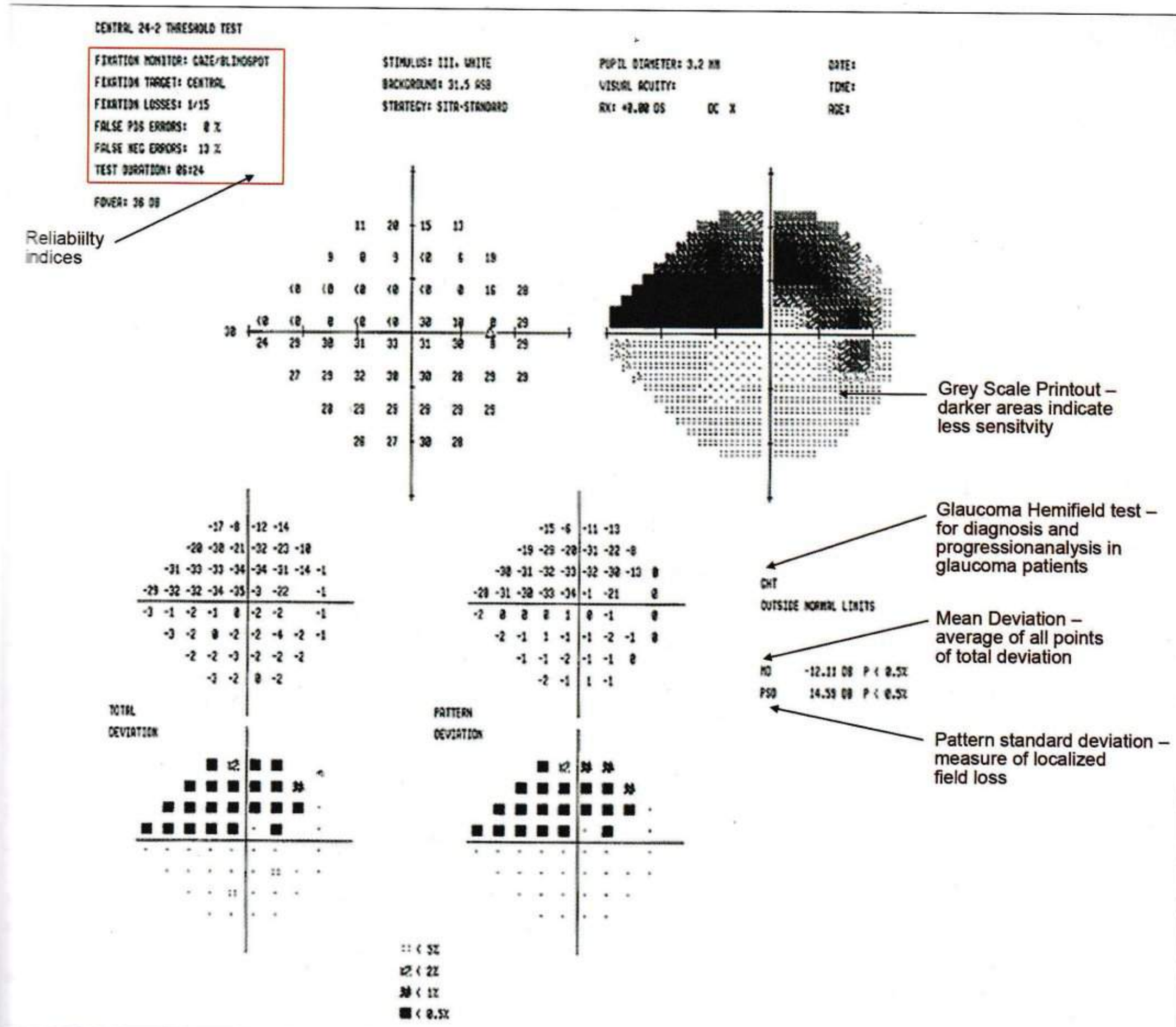


29. Ans. (a) Perimtery

Ref: Parson's 22/e, p. 291-292

Total deviation chart – tells the abnormal locations and degree to which they vary from normal levels.

Pattern deviation chart – total devation chart minus the average of the 17 worst locations – helps to **eliminate causes of generalized depression of visual filed such as cataract**


CENTRAL 24-2 THRESHOLD TEST
FIXATION MONITOR: GAZE/BLINDSPOT
FIXATION TARGET: CENTRAL
FIXATION LOSSES: 1/15
FALSE POS ERRORS: 0 %
FALSE NEG ERRORS: 13 %
TEST DURATION: 06:24
FOVEA: 36 DB
STIMULUS: III, WHITE
BACKGROUND: 31.5 ASB
STRATEGY: SITA-STANDARD
PUPIL DIAMETER: 3.2 MM
VISUAL ACUITY:
RX: +0.00 DS OC X
DATE:
TIME:
AGE:
Reliabiilty indices
Grey Scale Printout – darker areas indicate less sensitvity
Glaucoma Hemifield test – for diagnosis and progressionanalysis in glaucoma patients
CHT
OUTSIDE NORMAL LIMITS
Mean Deviation – average of all points of total deviation
MD -12.11 DB P < 0.5%
PSD 14.55 DB P < 0.5%
Pattern standard deviation – measure of localized field loss
TOTAL DEVIATION
PATTERN DEVIATION

30. Ans. (b) Open angle glaucoma

Ref: Shields 6/e, p. 107

Arcuate scotoma or Bjerrum scotoma is seen in the gray scale print out – thus a case of open angle glaucoma

31. Ans. (c) Phacomorphic glaucoma

Ref: Parson's 22/e, p. 301

Due to intumescent cataract (mature cortical cataract) as seen in the image, lens gets in contact with the pupillary margin and the block of aqueous flow from PC to AC leading to secondary angle closure glaucoma which is responsible for severe pain and the rise in IOP.

32. Ans. (c) Pigmentary glaucoma

Ref: Parson's 22/e, p. 303; Kanski 7/e, p. 358

Radial slit like transillumination, mid-peripheral iris transillumination defects with pigmentary deposit on the corneal endothelium (Krukenberg spindle) in a young myopic male is diagnostic of Pigmentary glaucoma.

33. Ans. (a) Congenital glaucoma

(Ref: Parson's 22/e, p. 294,304; Shields Glaucoma 6/e, p. 210)

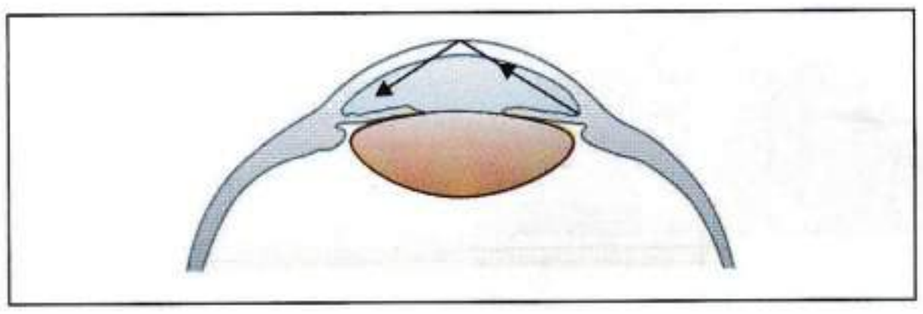
Onset in congenital glaucoma is less than 3 years of age. As the eye wall is still distensible in a child, the eyeball becomes enlarged (In the image the left eye appears more enlarged than the right). Marked photophobia with enlarged cornea and opacification are characteristic features.

Only confusing option could have been Megalocornea – but it is a congenital malformation which presents at birth and the cornea characteristically remains clear, and rarely associated with photophobia

34. Ans. (b) 46°

Ref: Shields 6/e, p. 41

The critical angle for the cornea-air interface is approximately 46°



Light rays originating in the recess of the chamber angle exceed the critical angle of the cornea-air interface and are reflected internally in the normal eye.

35. Ans. (d) Gonioscopy

Ref: Khurana 4/e, p. 546

Gonioscopy is examination of the anterior chamber angles. In it pupil dilation is not needed, in fact dilation of the pupil can hamper proper visualization of the angle structures.

All other options need pupil dilation (although they can also be done without dilation)

36. Ans. (a) Maklakov tonometer

Ref: Shields 6/e, p. 36

The Maklakov tonometer differs from the other applanation instruments in that a known force is applied to the eye, and the area of applanation is measured– a technique known as constant-force rather than constant-area applanation.

37. Ans. (a) Applanation Tonometry

Ref: Shields 6/e, p. 30

Refer text

38. Ans. (a) The facility of outflow of aqueous

Ref: Khurana 6/e, p. 511; Parson's 22/e, p. 614

39. Ans. (c) Indirect ophthalmoscopy

Ref: Yanoff 4/e, p. 963

Magnification of indirect ophthalmoscope is only 5 times, hence the details of the disc cannot be seen, thus, no use.

40. Ans. (a) Field of vision

41. Ans. (b) Moderately open angle

Ref: Shield's 6/e, p. 192

42. Ans. (b) Applanation tonometer

Ref: Shield's 6/e, p. 35

Goldmann's Applanation tonometer is the gold standard.

43. Ans. (d) Mackay-Marg tonometer

Ref: Becker-Shaffers, 8/e, p. 50

Mackay-Marg tonometer or **tonopen** or **Pneumatic tonometer** can be used to measure IOP in patients with irregular, edematous, scarred corneas.

Mackay-Marg tonometer is useful in these condition because its endpoint doesnot depend upon a light reflex sensitive to optical irregularity.

Tono-pen is useful because of its small applanating area, and little difference in measurements whether reading taken from central or peripheral cornea, thus enabling it to find a smooth area to applanate.

44. Ans. (a) Tonometry

Shallow AC with redness– points towards PACG in a female. In acute stages, IOP is markedly raised → Do tonometry followed by gonioscopy & fundus examination.

45. Ans. (b) Automated static perimeter

Ref: Shields 6/e, p. 104

Refer text

46. Ans. (a) Cupping of the disc

Ref: Shield's 6/e, p. 64

Increased c/d ratio, i.e., cupping is a pathognomonic feature of glaucoma.

47. Ans. (b) Normal Tension Glaucoma

Ref: Kanski 7/e, p. 346; Yanoff 3/e, p. 1159

Glaucomatous cupping (large and deep cup) along with glaucomatous visual field defects (paracentral scotomas are the most frequent) in patients with normal intraocular pressure suggests a diagnosis of Normal Tension Glaucoma (NTG).

48. Ans. (a) Also k/a Chronic... (c) Polygenic inheritance; (e) Fundus examination.

Ref: Parson's 22/e, p. 290-96; Shields 6/e, p. 66, 142, 176

Hypermetropic eyes with shallow anterior chamber & short axial length are predisposed to primary angle closure glaucoma.

Laser iridotomy is used for treatment *of primary angle closure glaucoma.*

49. Ans. (a) Common...; (c) Thin...; (d) Optic... and (e) Raised IOP

Ref: Khurana 4/e, p. 214-18,221; Parson's 20/e, p. 275-76

"Primary open-angle glaucoma is the most common form of glaucoma in Caucasians and Africans and constitutes about *half the primary glaucomas seen in Asians and Eskimos"-Parson's 20/e, p. 275*

50. Ans. (a) More...; (b) Shallo...; and (d) Shorter...

Ref: Parson's 20/e, p. 276-78

Refer text

51. Ans. (a) Horizontal cupping; (c) Macular oedema

Ref: Khurana 6/e, p. 230, 231

Glaucomatous optic disc cupping occurs as vertically. Macular edema is not a feature of glaucoma.

52. Ans. (d) Open angle glaucoma

Ref: Parson's 21/e, p. 285

Clinical features of POAG: Headache, eyeache, ***frequent changes in presbyopic spectacles*** and difficulty in dark adaptation.

53. Ans. (a) Contraction of isopters

Ref: Shields Glaucoma 6/e, p. 93

- Isopter contraction is the earliest visual field defect in POAG, but is non-specific.
- Focal defects, due to loss or impairment of retinal nerve fiber bundles, constitute the most definite early evidence of visual field loss from glaucoma.

54. Ans. (a) Optineurin

Ref: Khurana 6/e, p. 229; Shields 6/e, p. 143

This question asks hereditary glaucoma, which does not essentially have to be a case of congenital glaucoma.

Three genes have been found to be associated with Primary open angle glaucoma (POAG)–Adult onset

- Optineurin - 10p14-15
- Myocilin - 1q21-31
- WDR36 - 5q22.1

55. Ans. (d) Stainless steel

Ref: Khurana 6/e, p. 256; Shield's 6/e, p. 528

The Ex-Press implant—This biocompatible device is almost 3 mm long with an external diameter of approximately 400 microns. It is a non-valved, MRI compatible, **stainless steel device** with a 50 micron lumen. It has an external disc at one end and a spur-like extension on the other to prevent extrusion. This implant is not put under the conjunctiva but it is implanted under the scleral flap. This has totally avoided the complication of extrusion and hypotony.

56. Ans. (a) Acute angle-closure glaucoma

Ref. Parson's 21/e, p. 290; Yanoff & Ducker 3/e, p. 1165; Shield's 6/e, p. 198

Glaucomflecken are small grey-white anterior capsular or subcapsular opacities seen in the papillary zone, due to infarction of the lens fibers. They are pathognomonic of acute angle closure glaucoma.

57. Ans. (b) Lens opacity due to glaucoma

Ref: Parson's 22/e, p. 298

58. Ans. (a) Anterior...; (b) Pupil...

Ref: Khurana 5/e, p. 212, 503; Parson's 22/e, p. 4-6; Kanski 7/e, p. 391

Causes of Shallow Anterior Chamber

- Primary angle closure glaucoma (PACG)
- Hypermetropia
- Postoperative shallow anterior chamber
- Pupillary block by vitreous leak
- Malignant glaucoma
- Anterior perforations (perforating injuries or perforation of corneal ulcer).
- Anterior subluxation of lens
- Intumescent (swollen) lens

59. Ans. (b) Flat cornea

Ref: Parson's 21/e, p. 289

Predisposing factors for PACG

- *Shallow anterior chamber*
- *Short eye (short axial length)*
- *Smaller corneal diameter*
- Anterior dislocation of iris-lens diaphragm
- Hypermetropic eye
- Large lens (older/cataractous)

60. Ans. (c) Nd:YAG

Ref: Parson's 22/e, p. 299

Nd:YAG laser (1064 nm) is used for laser iridotomy.

61. Ans. (b) Atropine

Ref: Parson's 22/e, p. 297-298, 155

Prone dark room provocative test is used to precipitate closure of the angle in patient who are predisposed to angle closure glaucoma.

In PACG, never dilate pupil by using atropine, as it can also precipitate an attack.

62. Ans. (a) Deep angle

Ref: Parson's 22/e, p. 298

63. Ans. (c) Metamorphopsia

Ref: Khurana, 6/e, p. 244

64. Ans. (b) Oval and vertical

Ref: Parson's 21/e, p. 290

65. Ans. (a) 1-2% pilocarpine

Ref: Clinical ophthalmology 9/e, p. 335; Parson's 21/e, p. 291

66. Ans. (d) Acute angle closure glaucoma

Anticholinergic agents are sometimes used during endoscopy to cause smooth muscle relaxation to aid examination when difficulty is encountered. These agents cause pupillary dilatation, thus, precipitating acute angle closure glaucoma in susceptible patients. In patients with a history of glaucoma, glucagon is used instead of anticholinergics.

67. Ans. (c) Brimonidine

Ref: Parson's 22/e, p. 156; Goodman and Gilman 11/e, p. 1723

Apraclonidine and Brimonidine **can cross blood brain barrier** and may result in **CNS depression and apnea in neonates**. They are therefore contraindicated in children less than 2 years of age.

68. Ans. (c) Acetazolamide

Ref: KDT 5/e, p. 86, 87, 88

69. Ans. (a) Acetazolamide

Ref: Kanski 5/e, p. 227

70. Ans. (b) > (a) i.e. phynylephrine > Homatropine

Ref: Parson's 22/e, p. 64, 155

- Never dilate pupil in PACG
- Phenylephrine is a sympathomimetic drug with mydriatic action only, which is more potent than mydriatic action of homatropine.

71. Ans. (c) Brimonidine-decreased aqueous formation

Ref: Katzung 11/e, p. 159-160; KDT 6/e, p. 144, 5/e, p. 85

72. Ans. (d) Dipivefrine

Ref: Synopsis of Glaucoma, Wills eye institute, p. 220

Hypertensive uveitis means that uveitis which leads to increase in the IOP.

Pilocarpine and Prostaglandin analogues are contraindicated as they cause exacerbation of Uveitis as a side effect.

Dipivefrine being an alpha agonist also dilates the pupil and helps in treatment of uveitis.

73. Ans. (b) Myopia

Ref: Khurana 6/e, p. 449; Kanski 7/e; p. 386

Contraction of ciliary muscle results in accommodation and thus also cause transient, fluctuating myopia.

74. Ans. (a) Flouromethalone

Ref: American Academy of Ophthalmology, BSCS, Section 9, p. 186

Rimexolone, Loteprednol & fluorometholone have less potential to elevate IOP.

75. Ans. (a) Timolol

Ref: Side Effects of Drugs Annual: A Worldwide Yearly Survey of New Data. Jeffrey K Aronson – 2011, p. 982

Recent researches have shown that patients on long-term topical timolol for treatment of glaucoma have a much higher incidence of NLD obstruction.

Pilocarpine may lead to **punctual occlusion**. Another drug known to cause punctual occlusion is **physostigmine**.

76. Ans. (a) Latanoprost

Ref: Shield's 6/e, p. 405

77. Ans. (b) Phenylephrine

Phenylephrine will contract dilator pupillae which is arranged radially similarly to pilocarpine on sphincter pupillae which is circular.

78. Ans. (a) Timolol

Ref: Katzung 10/e, p. 692; Backer-Shaffer's 8/e, p. 399

79. Ans. (d) Watering of mouth

Ref: KDT 7/e, p. 154

Apraclonidine - Itching, lid dermatitis, follicular conjunctivitis, mydriasis, eyelid retraction, **dryness of mouth and nose** are common side effects.

80. Ans. (c) Alpha agonist

Ref: Parson's 22/e, p. 156

- Alpha agonists (**Brimonidine and apraclonidine**) **are contraindicated in hypertensive crisis & Parkinson's disease.**
- Dipivefrin is a prodrug which is converted into epinephrine inside the eyeball, so can safely be used in hypertension.

81. Ans. (d) Vigabatrin

Ref: Clinical Ocular Toxicology E-Book: Drug-Induced Ocular Side Effects; Frederick T. Fraunfelder, Frederick W. Fraunfelder, Wiley A. Chambers; Ryan's retina 5/e, p. 328

Visual field defects start a few years to months after starting the drug and range from a localized nasal defect of 30° to 40° in eccentricity and may **extend to complete concentric contraction**. The primary retinal effects are peripheral atrophy and nerve fiber bundle defects.

82. Ans. (b) Increasing uveoscleral outflow

Ref: Katzung 10/e, p. 152

83. Ans. (b) Topiramate

Ref: Kanski, 7/e, p. 869

Topiramate is an anticonvulsant also used in treatment of migraine. It can cause acute angle closure glaucoma with associated myopia due to ciliochoroidal detachment.

Angle closure Glaucoma may be precipitated by

- Loratidine and Fexofenadine (Anti-allergic drugs)
- Topiramate (Anti-epileptic) – due to uveal effusion/ciliary edema leading to forward displacement of the lens-iris diaphragm.

84. Ans. (d) Improved drainage of aqueous humour

Ref: Shield's 6/e, p. 434

Cholinergics with muscarinic action, like Pilocarpine, cause a contraction of the ciliary body resulting in change of its position. This altered position increases the flow of aqueous humour through the trabecular meshwork into the schlemm's canal, thus decreasing the IOP.

85. Ans. (a) Hypertension

Ref: Yanoff 4/e, p. 1023

Option d - Timolol (beta blocker) is contraindicated in A – arrhythmia, B – Bronchospasm, C – CHF, D – Diabetes
Option c – Topical timolol worsens CNS depression
Option b – HDL cholesterol is decreased

86. Ans. (b) Congenital glaucoma

Ref. Shields 6/e, p. 218-222; Parson's 22/e, p. 305, 616

87. Ans. (d) Congenital Glaucoma

Ref: Kanski 7/e, p. 374; Parson's 22/e, p. 304; Shields 6/e, p. 210, 223

An enlarged globe with an enlarged corneal diameter > 13 mm along with characteristic Haab's striae (double contoured opacities concentric to limbus) suggests the diagnosis of congenital glaucoma.

88. Ans. (d) Cornea is thin & clear

Ref: Parson's 22/e, p. 304-305

89. Ans. (c) Congenital glaucoma

Ref: Parson's 22/e, p. 304

90. Ans. (a) Lacrimation

Ref: Clinical examination in ophthalmology by Mukherjee p. 207

"Commonest symptom is watering"—Mukherjee

91. Ans. (c) Trabeculotomy with trabeculectomy

Ref: Pediatric glaucoma by zarate Vol I p. 144

"Primary combined trabeculotomy and trabeculectomy is safe, effective and sufficiently predictable to be considered the first choice of surgical treatment in primary congenital glaucoma".

92. Ans. (d) All the above

Ref: Kanski 7/e, p. 854; Yanoff 2/e, p. 1098

NF-1 is the most common phakomatosis. It is Autosomal Dominant (AD).

Ocular features

- Orbital
  - **Optic nerve glioma**
  - Spheno-orbital encephalocoele
- Eyelid – Ipsilateral **plexiform neurofibroma**
- **Glaucoma** – unilateral and congenital
- Iris lesions
  - **Lisch nodules** (Hamartomas)
  - Ectropion uveae
- Prominent corneal nerves
- Choroidal nevi
- Posterior subcapsular cataract

Correlate Box

NF1 (Von Recklinghausen disease)

Diagnostic Criteria – 2 or more should be present

- ≥6 **c**afé-au-lait macules
- Freckling (**A**xillary or inguinal) - Pathognomonic
- ≥2 **n**eurofibromas (any) or 1 plexiform neurofibroma (if it involves the eyelid, gives the characteristic S- shaped deformity)
- Optic **g**lioma
- **O**sseous lesion (such as sphenoid dysplasia)
- ≥2 **L**isch Nodules
- **F**irst degree relative with NF1

Mnemonic: CAN GOLF

S–shaped deformity of the eyelid caused by neurofibroma

93. Ans. (b) Congenital glaucoma

Ref: Shields 6/e, p. 221

94. Ans. (c) Increase with age

Ref: Khurana 4/e, p. 3-4, 205-06; Parson's 20/e, p. 117

"The depth and volume of the anterior chamber *diminish with age* and are related to the degree of ametropia. *Male subjects had larger anterior chamber dimensions than female subjects"- American Academy of Ophthalmology.*

The anterior chamber is about 2.5 mm to 3 mm deep in the centre in normal adults. It is *shallower in hypermetropes and deeper in myopes.*

95. Ans. (a) 2.5 to 3.5 mm

Ref: Khurana Anatomy 2/e, p. 53

96. Ans. (a) Ganglion cells

Ref: Parson's 21/e, p. 281

Raised intraocular pressure causes mechanical damage and affects vascular perfusion of optic nerve head leading to dysfunctional axoplasmic transport; eventually causing death of the ganglion cells.

97. Ans. (b) More common...; (c) Slit...; (d) Occur...

Ref: Parson's 22/e, p. 303; Shields 6/e, p. 273-277

98. Ans. (d) Pthisis bulbi

Option d - Please read Q48 (Ch 7 Uvea)
Option a - Please read Q97
Option b - Open Angle Glaucoma is the most frequent local alteration predisposing to RVO, its it comprises venous outflow by increasing IOP

↓

Raised IOP causes compression of central retinal vein as it exits through the fenestrations of Lamina Cribrosa

↓

Leads to thrombus formation distal to compression due to turbulent blood flow
(*Ref: Ryan's Retina 5/e, p. 441*)
Option c - 5% of eyes with intraocular tumours (malignant melanoma) develop a 2° elevation of IOP due to trabecular block or angle closure (NVI)

99. Ans. (b) Deposition of abnormal collagen in Descemet's membrane

Ref: Kanski 7/e, p. 369

100. Ans. (c) Insertion of drainage device

Ref: Ophthalmic Surg. 1990 Nov; 21(11): 786-93. Glaucoma triple procedures: efficacy of intraocular pressure control and visual outcome., Longstaff S1, Wormald RP, Mazover A, Hitchings RA.)
Triple procedure includes removal of cataractous lens, IOL implantation and trabeculectomy.
Note: Triple procedure (may also) refer to penetrating or selective keratoplasty combined with cataract extraction, and IOP implantation—Yanoff 4/e, p. 305
MC indication is Fuch's dystrophy

101. Ans. (b) Phakolytic glaucoma

Ref: Shields 6/e, p. 289; Parson's 21/e, p. 293

In 1900, Gifford described a form of open-angle glaucoma (thus deep AC) in patients of hypermature cataract—PHACO(–) LYTIC GLAUCOMA.

- Patient presents with acute onset of monocular pain and redness with gradual LOV
- High IOP, Corneal edema, hyperemia with heavy flare are seen.

102. Ans. (b) After surgery for cataract or glaucoma

Ref: Parson's 21/e, p. 295

103. Ans. (c) Inhibition of PGE

Ref: Khurana 6/e, p. 251

Steroid induced glaucoma

It is a type of 2°OAG.

Following theories have been put forward in the pathogenesis of steroid-induced glaucoma:

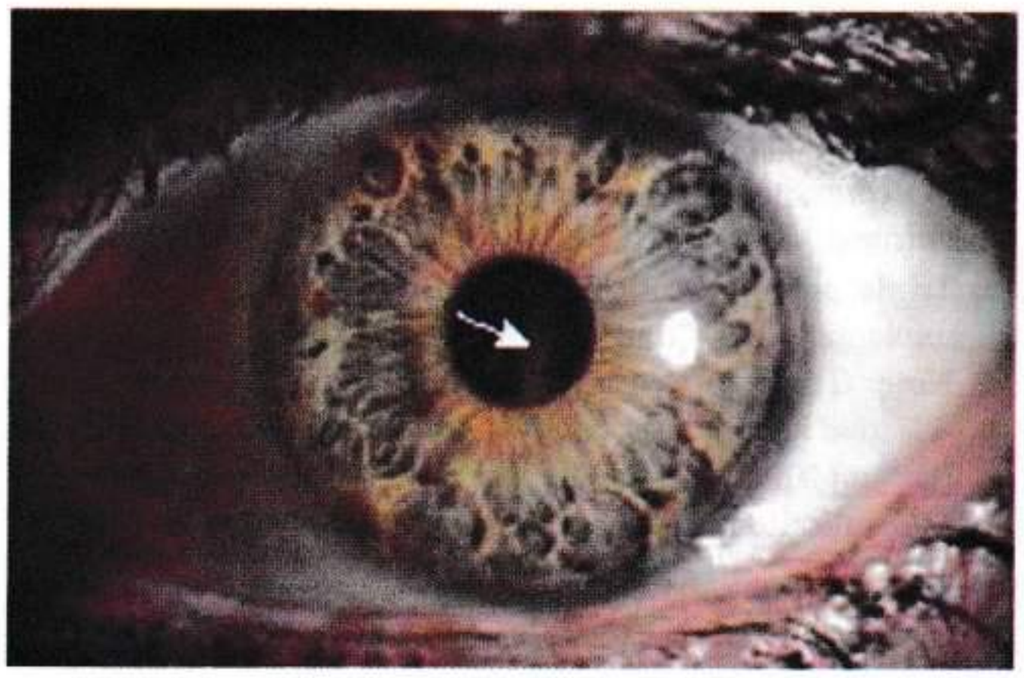
- **Glycosaminoglycans (GAG) theory:** Corticosteroids inhibit the release of hydrolases (by stabilizing lysosomal membrane). Consequently the GAGs present in the trabecular meshwork cannot depolymerize and they retain water in the extracellular space. This leads to **narrowing of trabecular spaces** and decrease in aqueous outflow.
- **Endothelial cell theory:** Under normal circumstances the endothelial cells lining the trabecular meshwork act as phagocytes and phagocytose the debris from the aqueous humour. Corticosteroids are known to suppress the phagocytic activity of endothelial cells leading to **collection of debris in the trabecular meshwork and decreasing the aqueous outflow.**
- **Prostaglandin theory:** Prostaglandin E and F (PGE and PGF) are known to increase the aqueous outflow facility. **Corticosteroids can inhibits the synthesis of PGE and PGF leading to decrease in aqueous outflow facility and increase in IOP.**

- IOP **rise** is **more** often with **topical** administration
- **Periocular** injection - most **dangerous** route of administration
- **Systemic** is **least** likely to induce glaucoma

104. Ans. (c) Involves posterior surface of cornea

Ref: Shields 6/e, p. 274

- Krukenberg spindle is an accumulation of pigment on the posterior surface of central cornea in a vertical, spindle shaped pattern.
- Not pathognomonic for pigmentary glaucoma



105. Ans. (d) Krukenberg's spindles

Ref: Shield's 6/e, p. p274

106. Ans. (a) Epidemic dropsy

Ref: Shield's 6/e, p. 335

The glaucoma is bilateral with open angle, normal outflow and normal Trabecular Meshwork. Aqueous assays reveal elevated PGE2 levels, histamine activity and total protein levels suggesting **hypersecretion** as the mechanism for IOP elevation.

Correlate Box

Epidemic Dropsy

Acute disease due to ingestion of Argemone Mexicana (adulterant in cooking mustard oil)

Characterized by leg edema, tenderness, erythema, rash with gastrointestinal symptoms and CHF

107. Ans. (c) Vitrectomy

Ref: Shield's 6/e, p. 483-490

108. Ans. (a) Active secretion

Ref: Khurana anatomy, 2/e, p. 62-63

109. Ans. (b) Temporal

Ref: Shields 6/e, p. 46

The temporal island of vision is more resistant and may persist long after central vision is lost.

110. Ans. (a) Cataract; (c) Iris cysts

Ref: Shields 6/e, p. 262-266

Refer to Image 2 for detailed explanation

Option a – In ICE syndrome, a retrocorneal membrane may grow over the anterior lens surface simulating the anterior lens capsule. It can be removed by Nd:YAG laser anterior capsulotomy

Option b – Corectopia – seen in Progressive iris atrophy

Option c – pigmented, pedunculated iris nodules are seen in Chandler syndrome, not iris cysts

Option d – Iris atrophic holes seen in progressive iris atrophy

111. Ans. (b) Glaucoma

(Ref: Kanski 7/e, p. 14, 382)

Sturge Weber syndrome – a congenital phacomatosis

Extra Mile

DON (Dermato-oculo-neural) syndrome

- **Cutaneous** – Port wine stain is diagnostic
- **Neural** – Leptomeningeal hemangioma
- **Ocular features**
  - Ipsilateral glaucoma – develops within 2 years of age in 60% cases, ipsilateral to the facial hemangioma in 30% cases
  - Arteriovenous malformations of episclera
  - Diffuse choroidal hemangioma
  - Iris heterochromia

Contd...

Child with Port wine stain of the left side in the distribution of the trigeminal nerve branches with buphthalmos

112. Ans. (b) Prostaglandin analogues

Ref: Retina by Stephen J Ryan 5/e, p. 1541; Kanski 7/e, p. 385

113. Ans. (b) Directly acting miotic

Ref: KDT 7/e, p. 105

It is a cholinomimetic alkaloid and acts directly on muscarinic receptors and also on ganglionic muscarinic receptors causing miosis, ciliary muscle contraction and fall in IOP.

114. Ans. (d) Congenital cataract

Ref: Parson's 22/e, p. 253; Yanoff 4/e, p. 1076, 1077)

Causes of Iris Neovascularization

Retinal Ischemia

- Diabetic retinopathy
- Central retinal vein occlusion
- Central retinal artery occlusion
- Retinal detachment
- Sickle cell retinopathy
- Retinoschisis
- Carotid artery occlusion

Inflammatory

- Chronic uveitis
- Endophthalmitis
- Vogt–Koyanagi–Harada syndrome
- Sympathetic ophthalmia

Tumors

- Choroidal/iris melanoma
- Ocular lymphoma
- Retinoblastoma

Irradiation

- External beam radiation
- Charged particle therapy
- Plaque therapy

Differential Diagnosis of Neovascular Glaucoma

- Uveitic glaucoma
- Acute angle-closure glaucoma
- Chronic angle-closure glaucoma
- Iridocorneal endothelial (ICE) syndrome
- Fuchs' heterochromic iridocyclitis

115. Ans. (d) Setons

(Ref: Khurana 6/e, p. 256; Shields glaucoma 6/e, p. 524)

The devices allowing aqueous outflow from anterior chamber to sub-tenon space are glaucoma valve implants. They were once referred to as SETONS/ Seton operation.

116. Ans. (c) Alpha 2 adrenergic agonists

(Ref: Shields 6/e, p. 543; Becker-Shaffer's Diagnosis and Therapy of the Glaucomas 6/e, p. 387)

'The use of brimonidine has been associated with bradycardia, hypotension, apnea and central nervous system depression in neonates and very young children.'

117. Ans. (c) Angle closure glaucoma

(Ref: Multiple)

Ideally, I.V. mannitol can be used in all the conditions listed in the question, but it is the primary treatment (amongst the options given) in cases of angle closure glaucoma to reduce the very high IOP in acute presentations.

Mannitol has four Food and Drug Administration (FDA)-approved uses:

- For the reduction of intracranial pressure and brain mass.
- To **reduce intraocular pressure** if this is not achievable by other means.
- To promote diuresis for acute renal failure to prevent or treat the oliguric phase before irreversible damage.
- To promote diuresis to promote excretion of toxic substances, materials, and metabolites.

118. Ans. (a) Timolol

(Ref: Kanski 7/e, p. 383; Katzung 12/e, p. 158)

Timolol is a non-selective beta blocker and thus acts on Beta 2 receptors also, leading to broncospasm and exacerbation of asthma

Betaxolol is a cardioselective (beta 1 blocker) and thus is free from this side effect

NOTES

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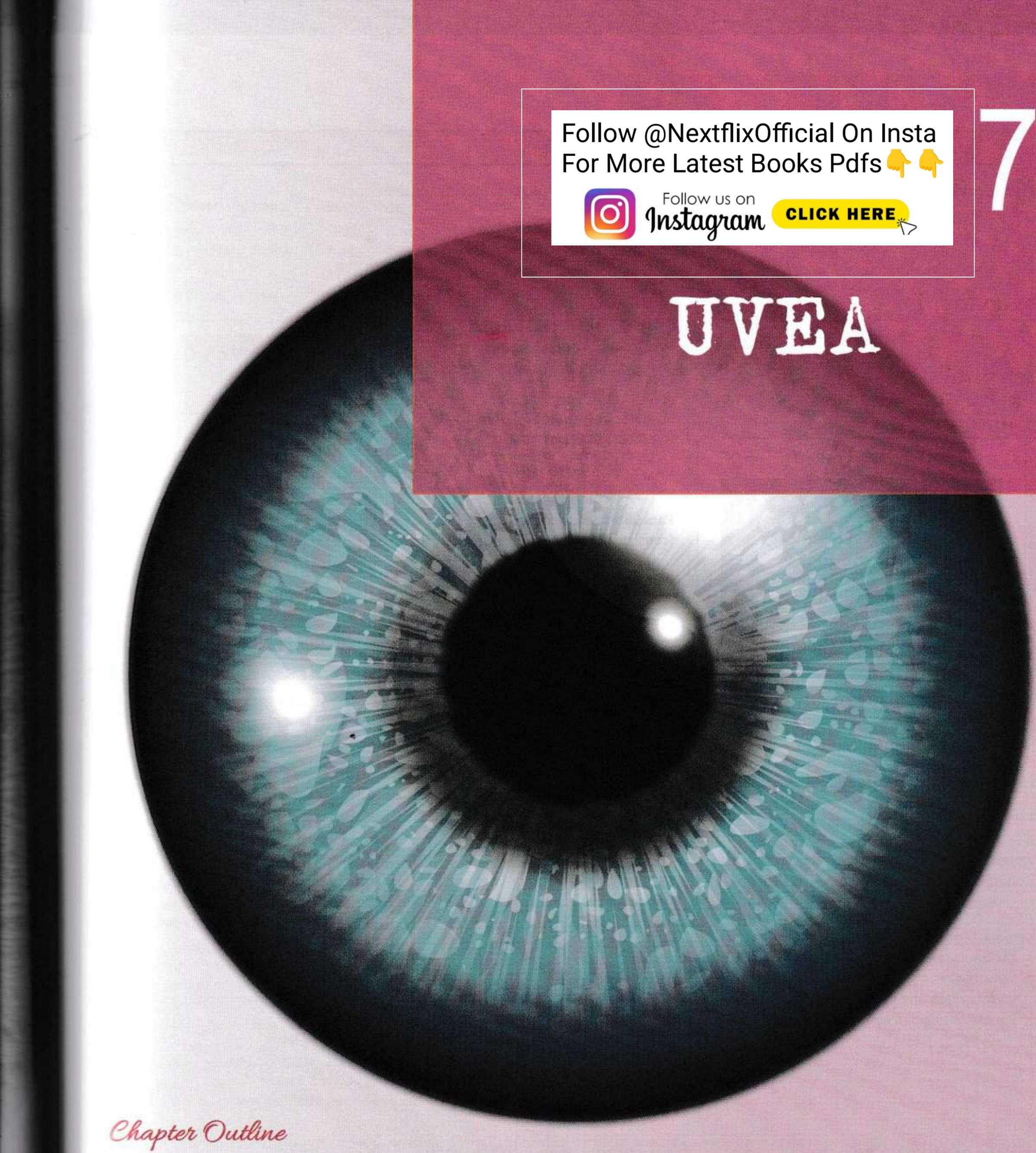
UVEA



Chapter Outline

Anatomy

Uveitis
- Classification
- Anterior Uveitis
- Intermediate Uveitis
- Posterior Uveitis
- Panuveitis
  - → Sympathetic Ophthalmitis
  - → VKH syndrome
  - → Sarcoidosis
  - → Behcet's disease

Endophthalmitis

Ocular HIV

Choroidal Melanoma

Choroidal Dystrophies

Surgical Removal of Eye
- Enucleation
- Evisceration
- Exenteration

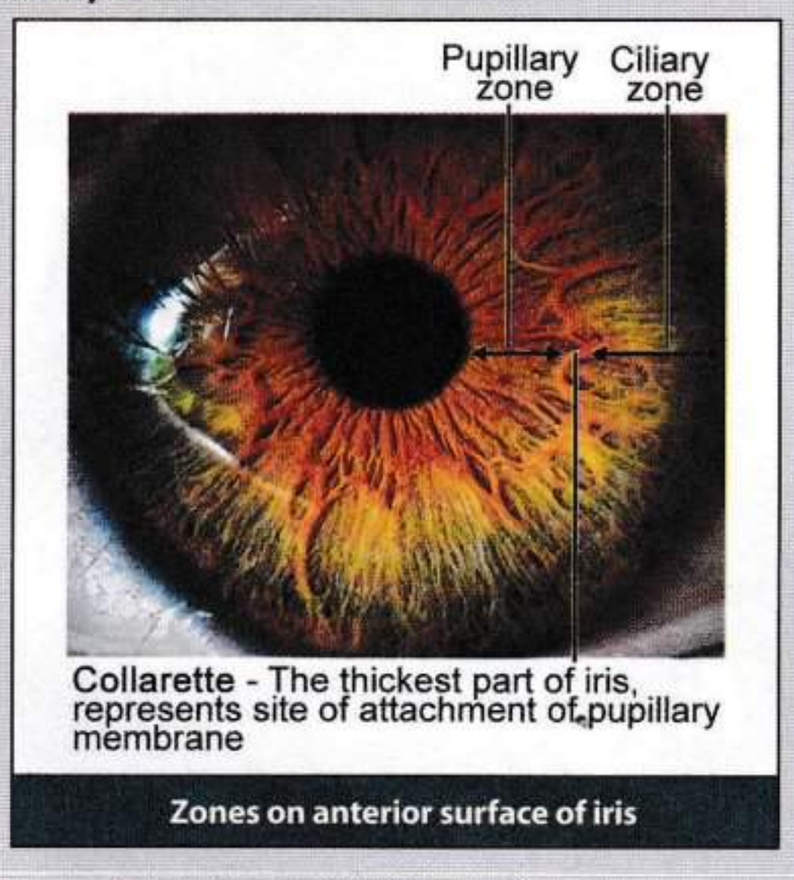
"Just because I am used to it does not mean it does not pain anymore."

UVEA

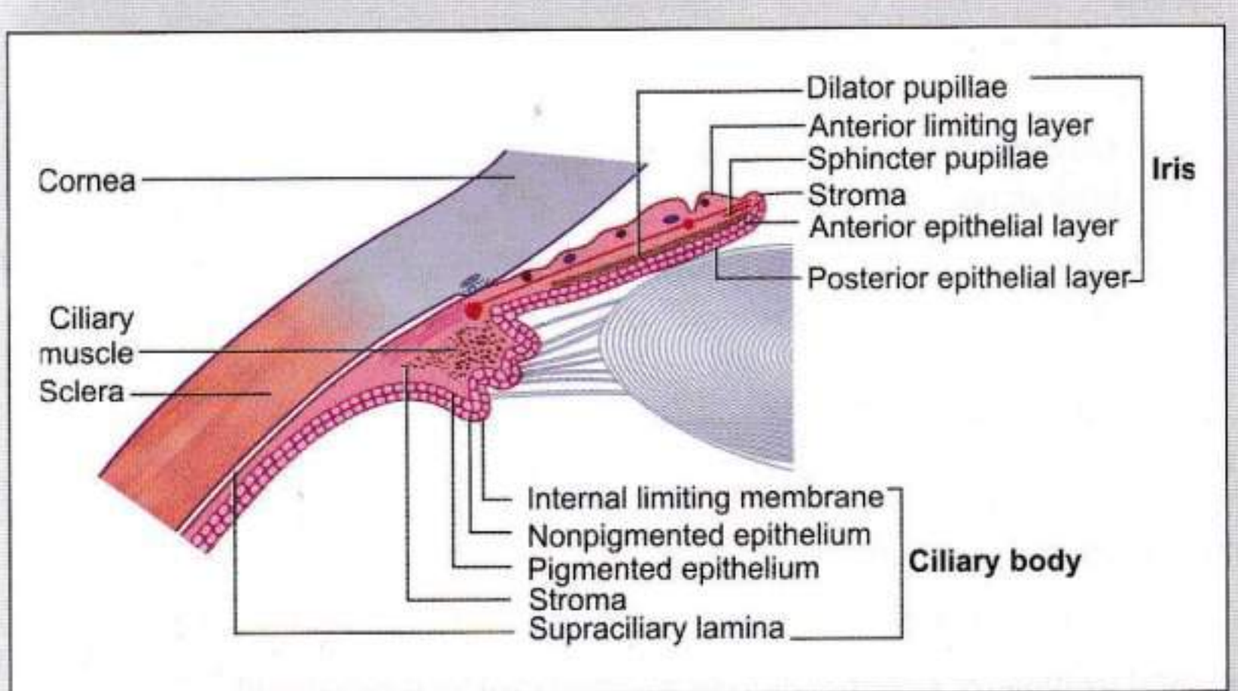
It is the **middle, vascular** layer of eyeball, and is divided into **three parts** (anterior to posterior)

Iris → Ciliary Body → Choroid

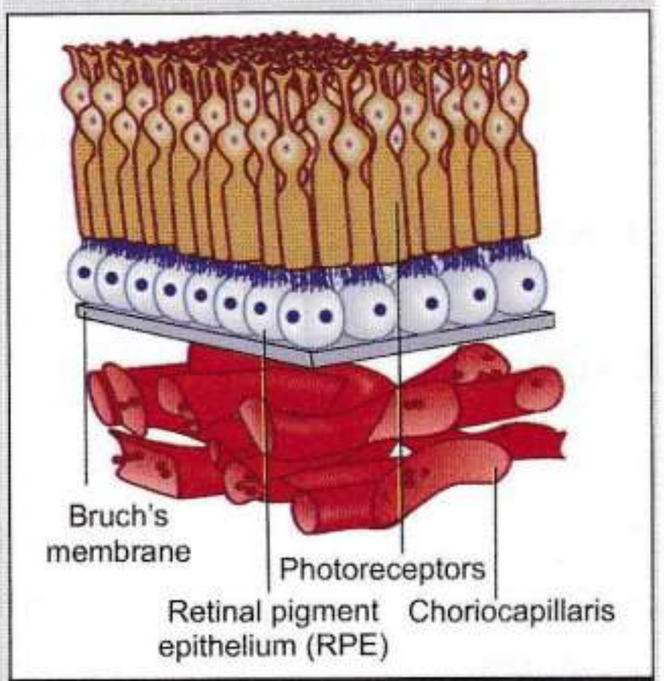
Anatomy

Iris	Ciliary Body	Choroid
Extent		
Pupillary margin to anterior surface of ciliary body	Scleral spur (situated 1.5 mm posterior to limbus) to Ora serrata	Ora serrata to optic nerve
Zones/Parts  Zones on anterior surface of iris	**Pars plicata** - Anteriorly (consists of 70 to 80 ciliary processes) **Pars plana** - Posteriorly	
Layers (outside to inside)		
4 **Anterior Limiting Membrane** Condensed part of stroma, contains melanocytes[Q] ↓ **Stroma** - Contains • Melanocytes and pigment clump cells • Vessels have non-fenestrated capillary endothelium and lack an internal elastic lamina • Sphincter pupillae and Dilator pupillae ↓ **Anterior (Outer) Epithelial Layer - lacks melanocytes** and is a continuation of outer pigmented epithelium of ciliary body and retinal pigment epithelium (RPE)	5 **Supraciliary Lamina** Continuation of anterior limiting membrane of iris ↓ **Stroma** - contains Ciliary muscle ↓ **Anterior (Outer) Pigmented Epithelium**	4 **Suprachoroidal Lamina** Potential space between this and sclera is **Suprachoroidal Space**, contains long and short posterior ciliary artery and nerves ↓ **Stroma** contains melanocytes and vessels • HALLER'S layer - Outer, larger vessels • SATTLER'S layer - Inner, medium vessels ↓ **Choriocapillaris** • Lined by basement membrane • **Nourishes retinal pigment epithelium and outer sensory retina** • Divided into non-overlapping lobules like in Liver

Iris	Ciliary Body	Choroid
Posterior (Inner) Pigmented Epithelial Layer Continuation of the inner non-pigmented epithelium of ciliary body and the neurosensory retina (cells of both epithelial layer have an APEX to APEX configuration)	**Posterior (Inner) Nonpigmented Epithelium** (Cells of both epithelial layers have APEX to APEX configuration) ↓ **Internal Limiting Membrane** Faces the vitreal cavity and continues as the inner limiting layer of retina	**Bruch's Membrane** (Innermost layer) • **Composed of** ▪ Basement membrane of RPE ▪ Inner collagenous layer ▪ Elastic tissue layer ▪ Outer collagenous layer ▪ Basement membrane of choriocapillaris



Anatomy of iris and ciliary body



Retinochoroid

High Yield

- **Iris Crypts**—site of hole creation during laser Iridotomy as lesser energy is required
- The **thinnest part of Iris - 'Root'** - thus, most common[Q] site for traumatic detachment (IRIDODIALYSIS)[Q]
- Iris color is determined by number of melanin pigments in superficial stromal melanocytes – Anterior limiting membrane
  Blue iris occurs if eumelanin (black)/ pheomelanin (red) ratio is decreased
- Neovascularization **(NVI)** most commonly affects the **anterior limiting membrane**
- Valleys of **Kuhnt**-spaces between the ciliary processes
- **Nonpigmented epithelium of ciliary processes—secretes aqueous humor**[Q]
- Pars plana is relatively **Avascular**, which helps in providing surgical access during vitreal or retinal surgeries[Q]
- Cytochrome P450 is present in ciliary body
- Eicosanoids are synthesized
  - PGE_2 - miosis
  - $PGF_{2\alpha}$ - IOP control
- **Choroid has firm attachments**[Q] **with sclera at** openings for
  - Optic nerve
  - Exit of vortex veins
  - Posterior ciliary arteries and nerves
- Bruch's membrane becomes thickened with age and produces hyaline excrescences known as **Drusen**[Q]

Uvea is one of the easier chapters to understand, learn and retain, as there is only one major pathology—UVEITIS. But at the same time tricky questions are also usually asked from uvea as uveitis has a lot of systemic associations. So, to study it, we focus on uveitis but with relevant information of systemic diseases.

UVEITIS

Inflammation of a part or the whole uveal tract is known as Uveitis.

CLASSIFICATION

Anatomical

	Inflammation of	Primary Site of Inflammation
Anterior Uveitis	Iris → Iritis Pars plicata → Anterior cyclitis } Iridocyclitis	Anterior chamber
Intermediate Uveitis	Pars plana → Posteror Cyclitis Peripheral retina → Basal retinochoroiditis Vitreous → Hyalitis	Vitreous
Posterior Uveitis	Choroid → Choroiditis Retina → Retinitis } Chorioretinitis/ Retinochoroiditis	Retina or Choroid
Panuveitis	Iris, Ciliary Body and Choroid	Anterior chamber, Vitreous, Retina or Choroid

Clinical Course

	Definition
Acute	Sudden onset with limited duration (<3 months)
Chronic	Persistent inflammation (>3 months), with **relapse in <3 months** after discontinuation of therapy
Recurrent	Repeated episodes, repeated by inactive periods lasting ≥3 months without treatment
Resistant	**To steroids**, if no clinical improvement after 2 weeks of maximal therapy **To immunosuppressives**, if no clinical improvement after 3 months of treatment

Pathological

Granulomatous	Due to autoimmune, infections or Type IV hypersensitivity
Non-granulomatous	Due to allergic, infective or exudative reaction

Though, there are many classification schemes, the most widely adopted is the anatomical classification. Thus, we study uveitis under it.

ANTERIOR UVEITIS (AU)

Inflammation of Iris and Pars plicata—**Iridocyclitis**[Q]. This is the most common form of uveitis.

Causes

Granulomatous

Sarcoidosis[Q]	Presents with AU as either **Lofgren syndrome** (Erythema nodosum + Bilateral hilar lymphadenopathy + Acute iritis) or **Heerfordt syndrome/Uveoparotid fever** (uveitis + Parotitis + fever + facial nerve palsy) with shortness of breath
Syphilis[Q]	AU is most commonly seen in late **congenital infection** along with interstitial keratitis. It presents with **Iris Roseolas**[Q] and characteristic poor response to steroids.
Leprosy[Q]	Chronic anterior uveitis with insidious onset, seen most commonly in Lepromatous **(LL) type**. It presents with pathognomonic **IRIS Pearls**[Q]
Tuberculosis[Q]	
Herpes[Q] **(HSV/HZV)**	Usually presents as keratouveitis with stellate keratic precipitates[Q], hyphema, sectoral iris atrophy along with ***ocular hypertension*** **(increased IOP)—hallmark**
Brucellosis[Q]	
Onchocerciasis	Medical therapy is never used as treatment of intraocular onchocerciasis. **Surgial removal is the treatment of choice**

Mnemonic

Causes of Granulomatous Anterior Uveitis – BOTH Have Late Syphilis

B	O	T	H	Have	Late	Syphilis	
↓	↓	↓	↓	↓	↓	↓	↘
Brucellosis	Onchocerciasis	TB	HSV	HZV	Leprosy	Syphilis	Sarcoidosis

Non-granulomatous

Acute

Idiopathic	Most common cause[Q]
HLA B27 related diseases	Seronegative spondyloarthropathies HIGH YIELD ■ **Ankylosing spondylitis**[Q]: **Unilateral**, recurrent AU with **lower back pain** and stiffness. 90% (**Highest Association**)[Q] patients HLA B27 positive, 25% (Highest)[Q] patients develop AU ■ **Reiter syndrome**[Q]: AU is Unilateral and recurrent, with history of travel and infection with shigella causing GI symptoms. **Triad** of urethritis, conjunctivitis and arthritis + keratoderma blennorhagicum + circinate balinitis ■ **Psoriatic Arthritis**[Q]: **Bilateral** AU with or without distal interphalangeal joint (DIP) arthritis + Nail pitting, onchyolysis + Plaque formation + **sausage digits**
Behcet's disease	Bilateral, recurrent AU with cold **mobile hypopyon**[Q]
Inflammatory bowel disease	AU is more common in Ulcerative colitis[Q] than Crohn's disease
Lens-induced	• Unilateral AU due to surgical or traumatic disruption of lens capsule leakage of proteins in mature or hypermature cataract – **Phacoanaphylactic uveitis** • **UGH syndrome** (Uveitis-Glaucoma-Hyphema) due to ACIOL[Q]
Posner-Schlossman syndrome[Q]	Unilateral recurrent AU with increased IOP
Drug-induced uveitis	**Mnemonic** **Causes – CML Please Relapse Slowly** **C** – **C**idofovir **M** – **M**etopronolol **L** – **L**atanoprost **P**lease – **P**ilocarpine **R**elapse – **R**ifabutin **S**lowly – **S**ulfonamides
TINU	Bilateral AU + Tubulointerstitial nephritis
Leptospirosis	

Mnemonic

Cause of Nongranulomatous Acute Anterior Uveitis

I	P	L	Is	B roadcast	L ive	D	T	H
↓	↓	↓	↘	↘	↓	↘	↘	↘
IBD	Posner Schlossman syndrome	Lens-induced	Idiopathic	Behcet's disease	Leptospirosis	Drug-induced	TINU	HLAB27 associated

Chronic

- ***Juvenile Idiopathic arthritis (JIA)***
  Most common disorder[Q] associated with AU in the **pediatric age group**, characterized by **arthritis ≥ 6 weeks duration before 16 years of age**.

Pauciarticular ≤ 4 joints involved	**Polyarticular** > 4 joints	**Still's disease**
• Type 1 girls, ANA positive; RF negative; • Type 2 - Boys	• RF positive; • RF negative (may develop uveitis)	
[Q]AU Most common in Type 1 (seronegative) pauciarticular		

IOL implantation is contraindicated in JIA[Q]
No congestion is present thus known as 'White Eye'

- ***Fuch's heterochromic iridocyclitis (FHI):*** Unilateral AU, presents with complaints only of *Floaters* (other symptoms of AU are Usually absent)

FHI has been shown to be related with rubella infection.

Signs of FHI

- **Heterochromia Iridis[Q]**

Due to loss of iris crypts (**Earliest sign**)
↓
Diffuse iris stromal atrophy—moth-eaten appearance (Iris trans-illumination defects are seen)
↓
Hypochromic Heterochromia Iridis or **Reverse Heterochromia** (in pale-eyed patient)

- **Amsler's Sign[Q]**: On Gonioscopy, fine-radial twig-like vessels are seen bridging over the angle, which may bleed on paracentesis
- **Cataract[Q]**: Most commonly posterior subcapsular (PSC) in >80% of cases
- Glaucoma: 25 to 60% of cases
- **Stellate[Q] shaped keratic precipitates** (KP)
- Koeppe nodules
- **No posterior synechiae[Q]**

Mnemonic

Features of FHI - No FUCHS

No	F	U	C	H	S
↓	↓	↓	↓	↓	↓
No posterior synechiae	Floaters	Unilateral	Cataract	Heterochromia iridis	Stellate KP

Clinical Features of Anterior Uveitis

Symptoms

- **Pain:** Dull aching, referred along branches of 5th (Trigeminal) cranial nerve to the forehead and scalp, characteristically worse at night.
- Redness
- Photophobia] Due to reflex between sensory fibers of V cranial nerve (CN) and motor fibers of VII CN
- Lacrimation] supplying the orbicularis oculi

- **Blurred vision** – due to[Q]
  - Aqueous turbidity
  - Induced myopia caused by ciliary spasm
  - Corneal haze[Q]
  - Cataract, Glaucoma, etc. as complications

Signs

(AU cases are examined by slit Lamp Biomicroscopy)

1. ***Circumcorneal/Ciliary Congestion***[Q]
2. ***Corneal Signs***
   - **Corneal edema** due to action of toxins or raised IOP
   - **Keratic precipitates (KP)** are collections of inflammatory cells on the **corneal endothelium**[Q], most commonly located **inferiorly**[Q] in a triangular pattern with the apex pointing up **(ARLT's triangle)**[Q] as a result of gravity and normal convection flow of aqueous[Q]

HIGH YIELD

Mutton fat KP	Granulomatous Uveitis	Large, fluffy composed of **Macrophages**[Q] and epitheloid cells, having a waxy/greasy appearance – yellowish
Fine, granular white[Q] KP	Nongranulomatous uveitis – Acute	Small, dirty white composed of **lymphocytes**[Q] and polymorphs
Pigmented KP	Nongranulomatous uveitis – Chronic	Crenated edges
Stellate KP[Q]	Herpetic uveitis Toxoplasmosis FHI	Fine and fibrillar, with a **diffuse**[Q] distribution

Mutton fat keratic precipitates

3. ***Anterior Chamber Signs***

- **Aqueous cells** – early and definite sign of active inflammation.
  - They indicate **disease activity**[Q] and their number reflects **severity**.
  - Neutrophils are mainly present.
- **Aqueous flare**[Q] – is the translucence of aqueous due to its high **albumin** content.
  - It is due to leakage of proteins into aqueous from leaking iris capillaries.

↓

Clinically recognized as suspended and moving particles in a beam of light; known as **Tyndall effect or Brownian movement**

Aqueous cells

EXTRA MILE

SUN working group grading scheme for anterior chamber cells

Grade	Cells in field
0	< 1
0.5+	1–5
1+	6–15
2+	16–25
3+	26–50
4+	>50

Seen on 1 mm × 1 mm beam project at 45°–60° angle, i.e. oblique illumination

EXTRA MILE

SUN working group grading scheme for anterior chamber flare

Grade	Description
0	None
1+	Faint
2+	Moderate (Iris & lens detail clear)
3+	Marked (Iris & lens detail lazy)
4+	Intense (Fibrin or plasmoid aqueous)

Seen on 1 mm × 1 mm beam project at 45°–60° angle, i.e. oblique illumination

Recent Advances

Laser Flare-Cell Photometry: Automated method for assessment of blood aqueous barrier breakdown and, thus, evaluation of aqueous cells and flare.

- **Hypopyon:** Pus in anterior chamber
  - Shifting hypopyon (mobile): Behcet's disease[Q]
  - Dense hypopyon (immobile): HLA B27-related diseases
- **Hyphema:** Blood in anterior chamber

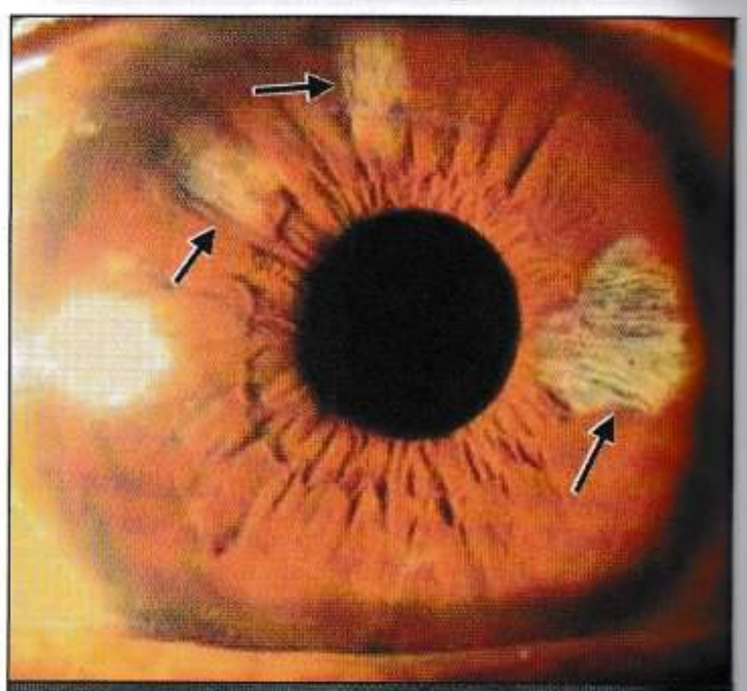
Mnemonic

Causes of Hyphema – HOTS

H erpetic uveitis
O phthalmia nodosa
T rauma
S yphilis

4. Iris Signs

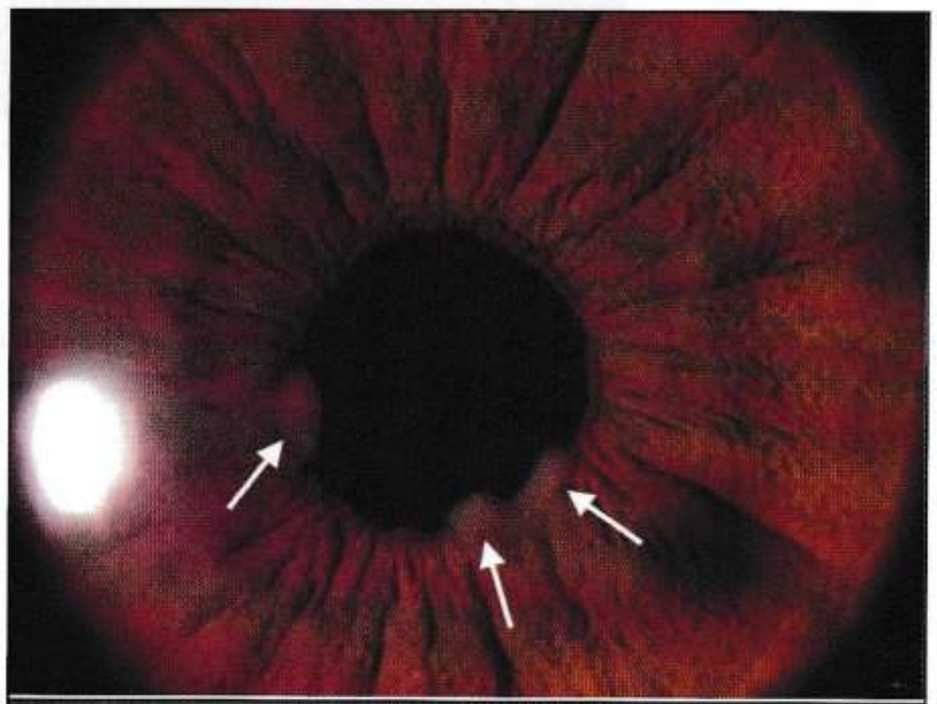
- **Pseudo-rubeosis:** Appearance of neovascularization, due to dilated iris vessels
- **Acute cases:** Iris is edematous (water sponge) and has a '**muddy**' appearance.
- **Chronic cases:** Due to repeated attacks **iris atrophy** occurs
  - **Sectoral iris atrophy:** Herpetic uveitis
  - **Diffuse iris atrophy:** Fuch's heterochromic iridocyclitis



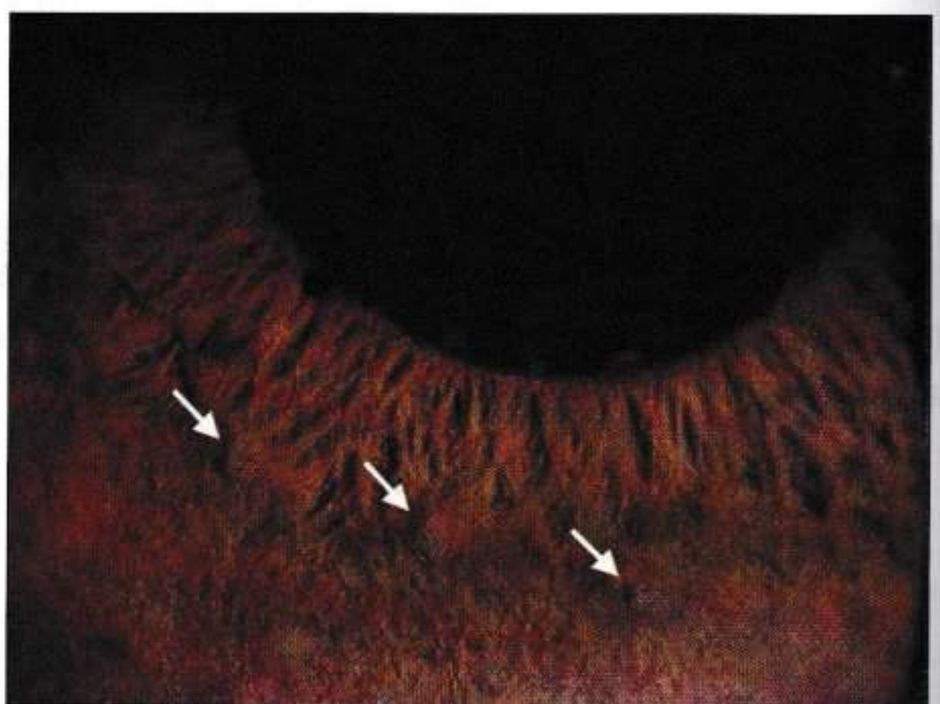
Patches of iris atrophy

- **Iris Nodules** – seen in Chronic AU

	Location	Pathology	Conditions
Koeppe[Q]	**Pupillary margin**[Q]	Ectodermal	Granulomatous and Non-granulomatous
Busacca[Q]	Along collarette (mid iris)	Mesodermal	Only Granulomatous
Berlin	Iris angle		

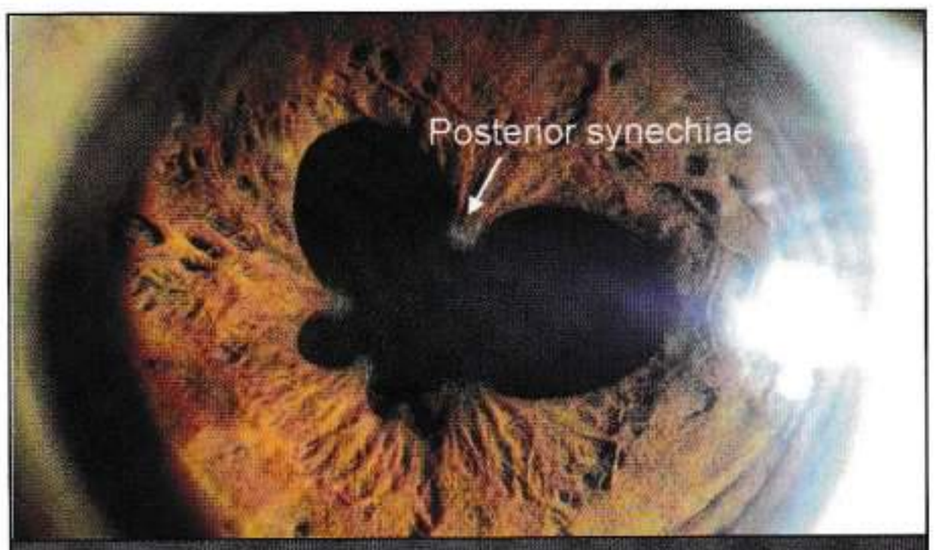


KOEPPE Nodules



BUSACCA Nodules

- **Posterior synechiae (PS):** Adhesions of pupillary margin to the lens capsule, due to outpouring of exudates into pupillary area, leading to membrane formation
  - i. **Localized PS** present
    ↓
    Dilate pupil
    ↓
    Pupil becomes **Festooned**[Q] (irregularly dilated due to dilatation of intervening portions)
  - ii. **Annular Synechiae /Ring synechiae /Seclusio pupillae**[Q]
    360° PS are present → No aqueous flow from PC to AC → Iris Bombe (Shallow AC) → Secondary Angle Closure Glaucoma
  - iii. **Total posterior Synechiae** – adhesion of complete posterior epithelium of iris to lens surface



Posterior synechiae and festooned pupil

Exudates in the posterior chamber organize to form Total posterior synechiae – adhesion between complete posterior surface of iris and lens capsule, causing deepening of AC

↓

They pour behind the lens also, forming a **Cyclitic Membrane**[Q], covering the ciliary body and the posterior surface of lens

↓

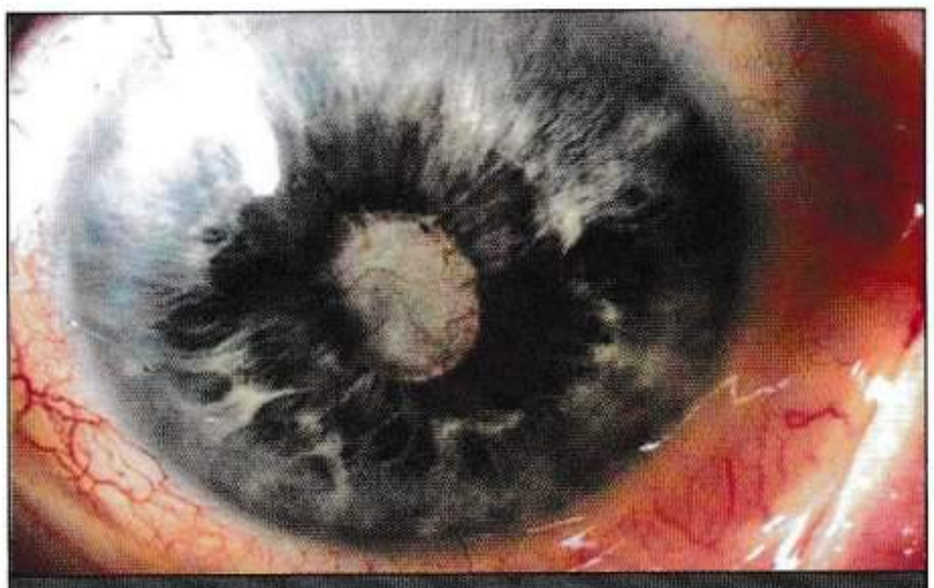
These exudates and the cyclitic membrane, damage the ciliary processes, diminishing the aqueous secretion and thus **causing Hypotony**

5. *Pupil Signs*

- **Occlusio pupillae:** Blocked pupil, due to organization of exudates across the pupil
- **Ectropion uveae**: Out turning of pupillary margin due to organizing exudates
- Acute cases: **Miosis**[Q]
- Chronic cases: Festooned pupil – irregularly dilated

6. *Intraocular Pressure*

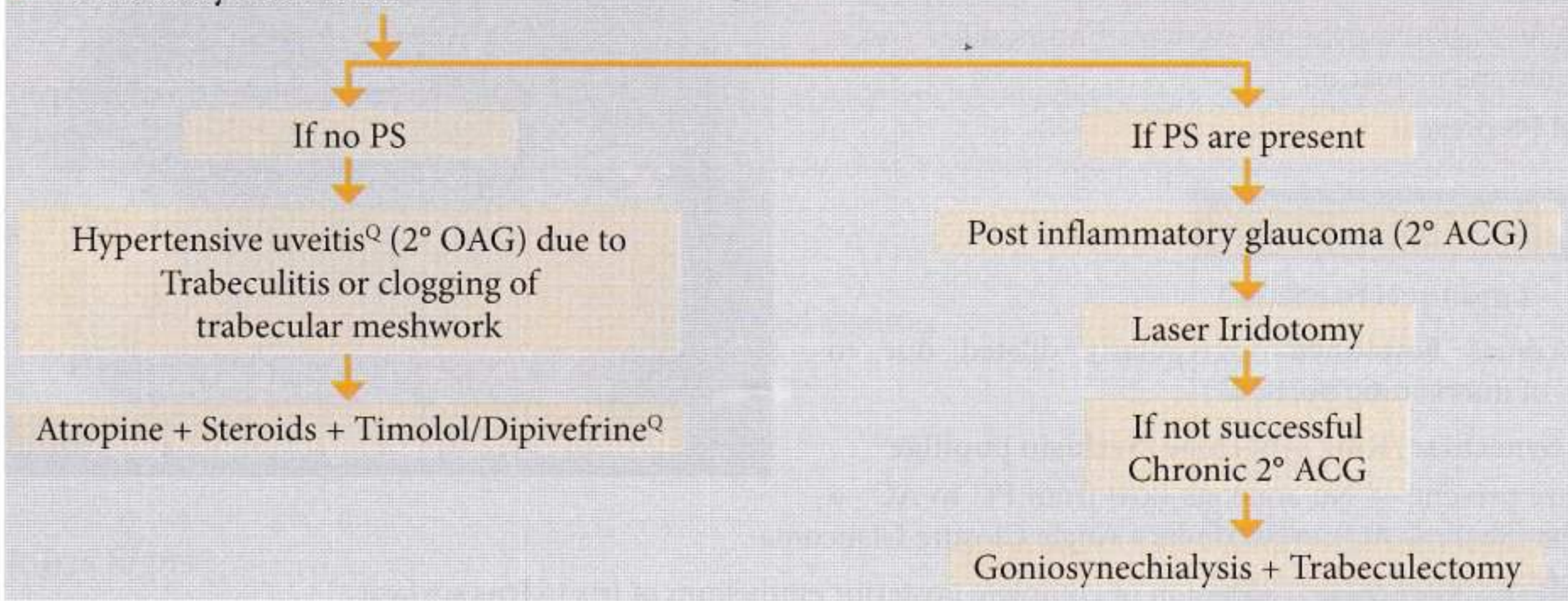
- **Acute cases: Raised,** due to Trabeculitis and clogging of trabecular meshwork by inflammatory cells.
- **Chronic cases: Decreased** – soft eye, due to ciliary body shutdown/atrophy


Occlusio pupillae and Pseudorubeosis

Complications

- **Complicated cataract:**[Q] Most common complication of AU in pediatric age group
- **Band-shaped keratopathy**: deposition of **calcium** in **Bowman's layer of cornea**
- **Cystoid macular edema**[Q]: Most common cause of loss of vision due to posterior segment involvement in AU
- **Phthisis bulbi**: Soft, shrunken eyeball
- Rhegmatogenous retinal detachment

- **Secondary Glaucoma**[Q]


If no PS
Hypertensive uveitis[Q] (2° OAG) due to Trabeculitis or clogging of trabecular meshwork
Atropine + Steroids + Timolol/Dipivefrine[Q]
If PS are present
Post inflammatory glaucoma (2° ACG)
Laser Iridotomy
If not successful Chronic 2° ACG
Goniosynechialysis + Trabeculectomy

- 2°ACG is the most common complication of recurrent AU
- Pilocarpine and Latanoprost ($PGF_{2\alpha}$ analogues) are contraindicated for control of IOP in hypertensive uveitis, as their side effect is uveitis

Treatment

- **Mydriatic and cycloplegic agents**
  - Beneficial for breaking or preventing PS
  - Relieving ciliary spasm[Q]
  - Decrease hyperemia and congestion
- **Topical steroids** – the best agents to control inflammation

Correlate Box

Drug	Duration
Tropicamide 0.5%, 1%	6 hours
Cycloplentolate 0.5%, 1%	24 hours
Homatropine 2%	2 days
Atropine 1%	2 weeks

Mydricaine- Adrenaline (+) atropine (+) proparacaine, given subconjunctivally (0.3 mL)

Short-acting steroids as difluprednate 0.05%, loteprednol 0.5%, fluormetholone 0.1%, rimexolone 1% are preferred over prednisolone 1%, Dexamethasone 0.1%
Complications are numerous - elevation of IOP, Posterior subcapsular cataract, corneal melting, exacerbation of herpetic keratitis.

- Antimetabolites – Azathioprine (Behcet's disease), methotrexate (JIA, Sarcoidosis)
- Calcineurin inhibitors
- Antibiotics – for infectious causes

The million dollar question – what is DOC for AU?
Steroids or Atropine
Both are first-line drugs, you have to use both in almost all cases.
Usually, we taper steroids after control of inflammation and continue mydriatic-cycloplegics for longer.

INTERMEDIATE UVEITIS (IU)

Inflammation of pars plana, peripheral retina and vitreous

Causes

- **Idiopathic: Most common cause**
  Pars Planitis: Subset of IU where there is snowbank or snowball formation in the absence of an associated infection or systemic disease (i.e. Idiopathic)

- Associated with
  - Sarcoidosis
  - Multiple sclerosis
  - Syphilis
  - Peripheral toxocariasis
  - Tuberculosis
  - Lyme disease
  - Primary Intraocular lymphoma – presents in > 50 years of age

Clinical Features

Symptoms

Presents with insidious onset, bilateral, **blurred vision** and **floaters**

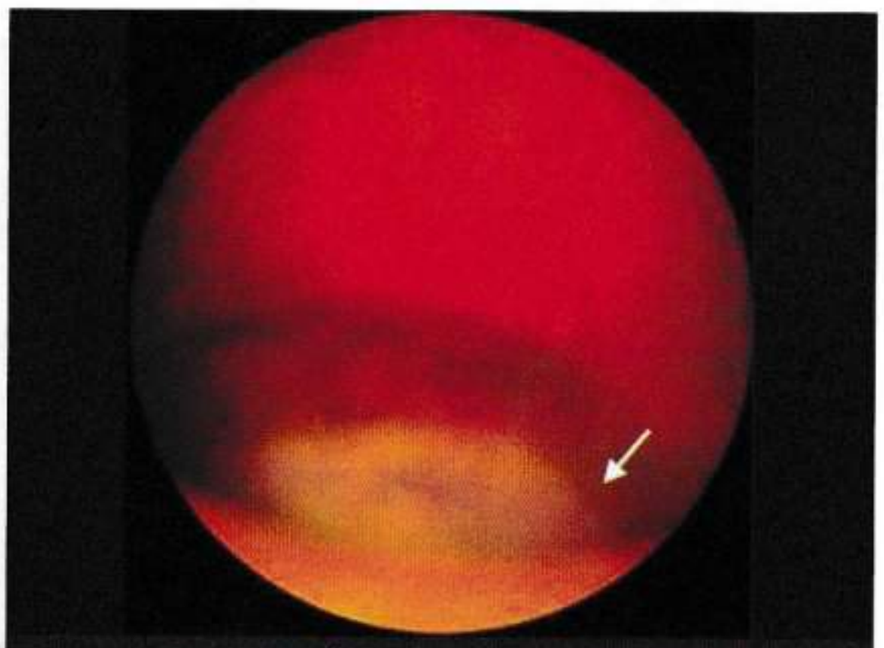
Signs

- Spillover anterior uveitis and vitritis – hallmark
- Anterior vitreous cells – due to inflammation of vitreous
- Snowballs: aggregation of cells in vitreous
- **Snow banking**:Q Fibrovascular plaque, most commonly seen inferiorly Q
- Retinal periphlebitis with venous sheathing

Correlate Box

Lyme Disease

- Due to Tick exposure
- Stage 1 – Erythema chronicum migrans + follicular conjunctivitis
- Stage 2 – IU + arthritis (knee)
- Stage 3 – B/L keratitis + episodic arthritis



Snow Banking (seen on INDIRECT ophthalmoscopy with scleral indentation only)

Complications

- **Cystoid macular edema**:Q Most common cause of visual loss
- Epiretinal membrane formation
- Posterior subcapsular cataract
- Vitreous opacification

Treatment

Periocular steroids (drug of choice) ↔
- Trans-septal or subtenon 'injection (NOZIK technique) is given
- Triamcinilone (40 mg) is most commonly used
- Complications: Ptosis, periorbital hemorrhage, globe perforation

↓ Not effective

Systemic predinsolone

↓ Fails

Immunomodulatory therapy (IMT) ↔ Azathioprine and mycophenolate mofetil

↓ Fails

Pars plana vitrectomy and peripheral laser photocoagulation of snowbank

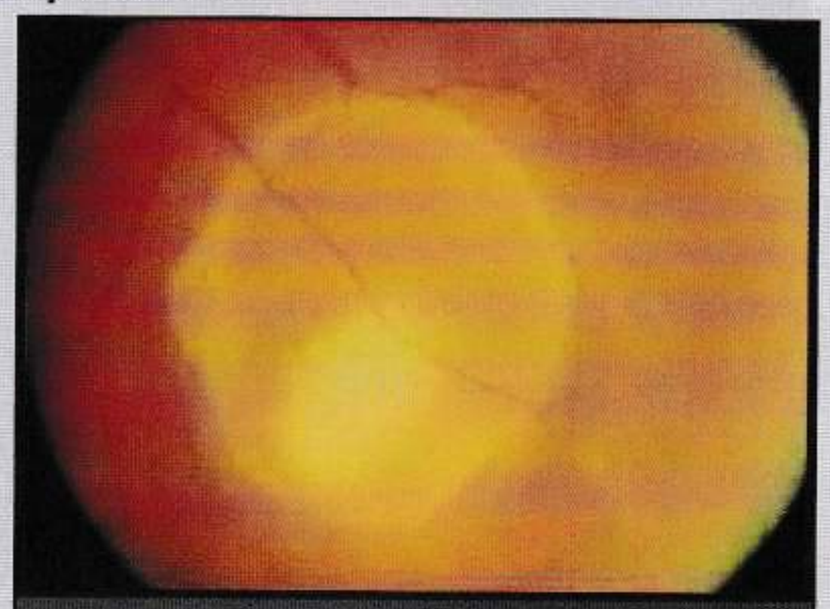
POSTERIOR UVEITIS

Inflammation of **choroid and retina** (As the outer layers of retina are dependent upon choroid for nutrition, choroiditis almost always secondarily causes retinitis).

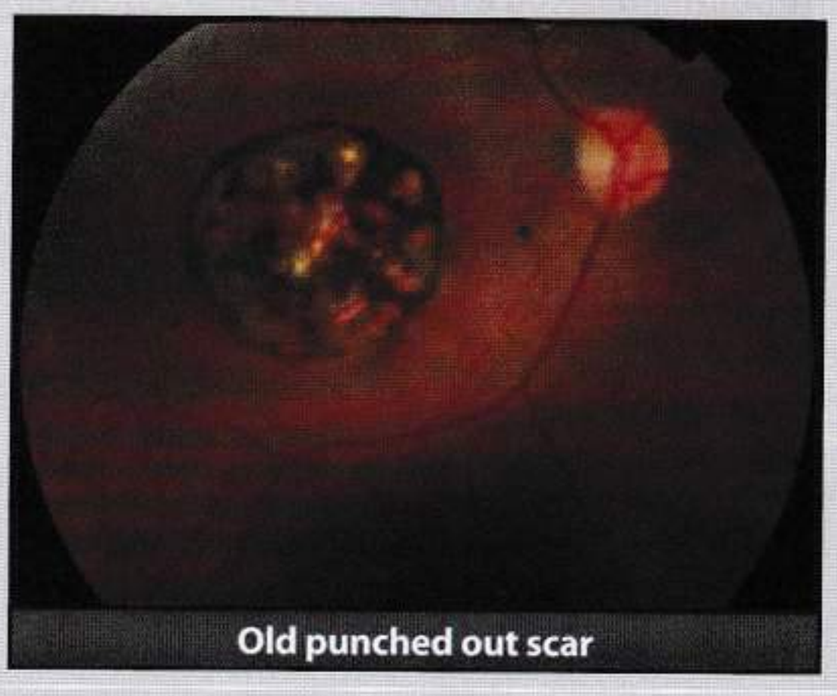
Causes

Infectious

Toxoplasmosis



Fundus headlight in fog appearance



Old punched out scar

EXTRA MILE

- Most common cause of retinochoroiditis
- Associated with ingestion of raw (in cooked) meat
- **Humans are intermediate host**, cats are definitive host
- Characteristic **Head Light in Fog[Q] – appearance** due to severe vitritis
- Kyrieleis Arteriolitis – perivasculitis with venous sheathing
- Visual loss due to direct Macular[Q] lesion – mostly Unilateral
- Satellite lesions – new foci of **necrotizing**[Q] granuloma seen around an old pigmented scar
- Healed lesion has a characteristic '**Punched Out' atrophic scar** with hyperpigmented border
- Congenital Toxoplasmosis[Q]: Retinochoroiditis + Hydrocephalus + Intracranial calcification

Toxocariasis

- Toxocara canis: Lifecycle completion in Dogs – Transmission is Feco-oral
- **Ocular Features**
  - Seen in older children > 5 years
  - Eosinophilia is absent
  - Always **Unilateral visual loss**
  - Causes three syndromes
    - Chronic endophthalmitis – **Leukocoria**[Q]
    - Localized Macular granuloma
    - Most common – Peripheral granuloma
- Treatment: Only steroids needed, no anti-helminthic drugs

CMV Retinitis

Above three are causes of FOCAL chorioretinitis with Vitritis

Syphilis

- Most common presentation is in early congenital infection with multifocal choroiditis causing **SALT and PEPPER fundus**
- Characteristic POOR response to steroids

Contd...

Herpes Virus (HSV/HZV)	• **Acute retinal necrosis (ARN)**: Multifocal, Unilateral **chorioretinitis** with **vitritis** (Posterior Pole is characteristically SPARED) and **occlusive retinal arteriolitis** ↓ Coalescence of lesions-full thickness necrosis with circumferential spread ↓ Optic atrophy and Retinal Detachment (Retinal Detachment causes visual loss) • Vasculitis – more common with HZV • **Progressive outer retinal necrosis (PORN)** – if HZV infection in AIDS • Non-necrotizing retinitis
Tuberculosis	• **Uveitis is most common presentation of secondary ocular TB** • Disseminated choroiditis is the most common type of uveitis seen • May have serpiginous pattern

Non-infectious

- Collagen vascular diseases: SLE, Polyarteritis nodosa, Wegner's granulomatosis
- Sarcoidosis
- Behcet's disease
- **Inflammatory chorioretinopathies/White dot syndromes**

	Birdshot Chorioretinopathy[Q]	Serpiginous Choroiditis	MEWDS	AMPPE	Punctate Inner Choroidopathy (PIC)	AZOOR
Age	Older (**30–70**)[Q]	Middle (20–60)	Young (10–45)	Young (20–45)	Young (18–40)	Young
Laterality	**Bilateral**[Q]	Bilateral	Unilateral	Bilateral	Bilateral	Bilateral
Onset	Insiduous	Variable	Acute	Acute	Acute	Insiduous
Course	**Chronic**[Q], recurrent	Chronic, recurrent	Self-limited	Self-limited	Self-limited	Chronic-recurrent
Associations	HLA-A29	**HLA-B7**	—	—	—	—
Sex	**F** > M	M > F	F (Myopic)	M = F	F (Myopic)	F (Myopic)
Vitritis	PRESENT	Absent	Mild/Absent	Mild/Absent	Absent	Mild/Absent
ERG	Abnormal	NORMAL	Abnormal	Abnormal	NORMAL	Abnormal
Visual prognosis		EXCELLENT		Good		
Special points	Primary stromal choroiditis, **CME occurs commonly**	Also known as HELICOID choroidopathy, Causes CNVM	Macula is spared		Choroidal Neovascular membrane (CNVM) develops in 40% patients.	Central vision is spared

Clinical Features

Symptoms

- Floaters (peripheral lesion) with or without loss of vision (central lesion), which is **Painless**[Q]
- **Scotoma:** Positive (early, active stage), negative (late, healed stage)
- **Metamorphopsia**[Q]: Distortion of images causing apparent change in size of objects
- **Photopsia**[Q]: Flashes of light due to retinal irritability

Photopsia and floaters are also seen in Rhegmatogenous retinal detachment

Signs

- Vitritis/Hyalitis-inflammation of vitreous
- Chorioretinitis

Recent Focus/Active	Healed
• Yellowish nodule (due to choroidal infiltration hiding red reflex of choroid) • Hazy and ill-defined margins • Associated perivascular cuffing	• White areas (due to atrophy of choroid and retina making scleral white reflex visible) • Sharply delineated margins • Clumping of pigments at margin (due to RPE atrophy)

- Pre-retinal/Sub-retinal fibrosis
- Vasculitis[Q]

Complications

- Rhegmatogenous retinal detachment
- Choroidal neovascularization (CNV)

Causes of Choroidal Neovascularization

Mnemonic

Causes of CNV

Just **PASS** **B**y **M**argin **I**n **PAST** **V**iva **V**oce

Degenerative diseases	
• **A**ge-related macular degeneration • Myopic degeneration • **A**ngloid streaks • **Juxt**afoveal retinal telangiectasis	• **V**itelliform macular dystrophy • **Pattern** dystrophies • **S**targardt macular dystrophy
Inflammatory	
• **V**ogt-Koyanagi Harada syndrome • **B**ehcet's syndrome • **S**ympathetic ophthalmia • **M**ultifocal choroiditis	• **S**erpiginous choroiditis • Laser photocoagulation • **P**unctate inner choroiditis
Infectious	
• Toxocariasis	• **T**oxoplasmosis

- Cystoid macular edema
- Glaucoma: Secondary angle closure – Due to forward rotation of ciliary body and lens-iris diaphragm

Treatment

- Infective cases – Treat the cause
- Non-infective cases
  - **Steroids: Systemic** are the drug of choice[Q]
  - Steroid sparing agents – Used if
    - Contraindication to steroids
    - Reversibility of disease process
    - Failure to respond to steroids, as in chronic cases

Extra Mile

Sakura program – Sirolimus intra-arterial injection, (440 µg) as monotherapy for noninfectious posterior uveitis.

Mu trial – Compares efficacy of Fluocinolone acetonide implant to systemic corticosteroid therapy

Luminate trial – VOCLOSPORIN oral capsule[Q]

Recent Advances

Adalimumab (Humira) has been approved by FDA for the treatment of noninfectious Intermediate, Posterior, Panuveitis

Approval was based on VISUAL-I and II studies

PANUVEITIS

Is involvement of **all compartments of the eye** – anterior chamber, vitreous, retina or choroid, with no single predominant site of inflammation.

Causes

Idiopathic	Infections	Immune Related
	• Tuberculosis • Syphilis • Lyme disease • Leptospirosis	• Sarcoidosis • Behcet's disease • VKH syndrome • Sympathetic ophthalmitis

Having already discussed in the preceding sections about the infectious disease, we will discuss here the non-infections causes.

Behcet's Disease

Behcet disease is an idiopathic, chronic, relapsing, occlusive systemic disease

HLA B5, B51 association

- Ocular involvement is usually bilateral[Q], more common in males (25-35 years), and occurs within 2 years of oral ulceration (70% cases)
  - Acute anterior Nongranulomatous uveitis – recurrent with a transient **mobile[Q] 'Cold' Hypopyon**
  - Obliterative, necrotizing retinal vasculitis – affecting both arteries and veins (MC presentation)[Q]
  - Vitritis (CME) – universal in active disease
  - Retinal infiltrates
  - Optic atrophy

Correlate Box

Diagnostic system for Behcet's disease (International study group)[Q]

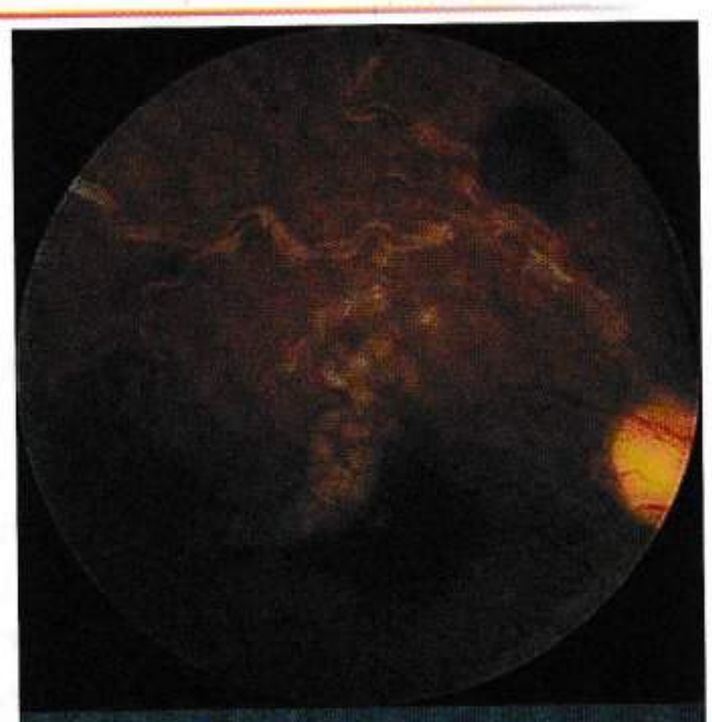
- Recurrent painful oral aphthous ulcers (at least 3 or more times per year)
- Plus 2 of the following
  - Recurrent genital ulceration
  - Ocular inflammation
  - Skin lesions – erythema nodosum, folliculitis, acneiform nodules
  - Positive cutaneous Pathergy test

Sarcoidosis

- Inflammatory, multisystem granulomatous[Q] disease

Ocular Clinical Features

- **Most common manifestation: Anterior granulomatous uveitis**
- Intermediate uveitis
- Posterior uveitis
  - Periphlebitis (inflammation around veins)
  - Perivenous infiltrates appearing as **Candle Wax Drippings[Q]**
  - Vitreous infiltrates giving String of Pearls appearance
  - Pre-retinal nodular granulomas – **Landers sign**
- **Panuveitis – Bilateral, Granulomatous[Q]**
- Optic neuropathy → (Diplopia/ptosis due to associated CN palsy)
- Lacrimal gland infiltration → Dacryocystitis
- Keratoconjunctivitis sicca → **Dry eye**
- Conjunctival nodules
- Nummular interstitial keratitis



Candle wax drippings

Perivenous infiltrates

Correlate Box

- **Pathology** – T helper cell CD4+ mediated process, with peripheral anergy due to type IV hypersensitivity response. Basic lesion is a Noncaseating granuloma
- **Systemically**, most commonly affects the Lung (Bilateral hilar lymphadenopathy, reticulonodular infiltrates, pulmonary fibrosis)
- **Diagnosis**
  - Serum ACE levels, Serum globulin, Serum Ca^{2+}, Serum Lysozyme are increased
  - Conjunctival biopsy[Q]
  - Lacrimal and salivary gland biopsy[Q]
  - Chest X ray – Best Screening method
  - CT/MRI
  - Vitreous tap – CD4/CD8 ratio > 3.5
  - Kveim test is positive

Vogt-Koyanagi-Harada Syndrome (VKH)

VKH syndrome is an idiopathic, multisystem autoimmune disease featuring **inflammation of melanocyte containing tissues** affecting the uvea, ear, skin and meninges.

Ocular Signs

- **Bilateral granulomatous Panuveitis**[Q]
- Posterior Uveitis
  - Diffuse choroiditis
  - Exudative (serous) retinal detachment
  - **Sunset glow fundus** – due to diffuse Retinal pigment epithelium (RPE) atrophy
  - **Sugiura sign** – perilimbal vitiligo (depigmented lesions)
  - Dalen fuch nodules
  - Subretinal fibrosis, cataract, glaucoma, CNV
- Anterior uveitis

Correlate Box

Systemic findings

- **Neurologic/Auditory**
  - Meningismus
  - Tinnitus
  - Cerebrospinal fluid pleocytosis
- **Integumentary** (Always after ocular or CNS disease)
  - Alopecia
  - Poliosis
  - Vitiligo

Sympathetic Ophthalmitis

- Sympathetic ophthalmitis is a **Bilateral**[Q]**, autoimmune (T-cell mediated), Granulomatous**[Q] **Panuveitis.**

Cause

It develops due to trauma to 1 eye (Exciting Eye)

↓

2 weeks—3 months

↓

Uveitis in the Uninjured, fellow eye (Sympathizing Eye)

High Yield

- **Most common cause:** Accidental[Q], penetrating[Q] trauma to ciliary body[Q]
- **Ciliary body is known as the dangerous area of eye**
- Sympathetic ophthalmitis develops in the non-traumatic eye

Very easy to understand and remember Sympathetic ophthalmitis in Fun Way

In a Bollywood movie, there is a heroine (Rich) and a hero (Poor). Both fall in love, but when heroine's father gets to know this, he gets angry and sends goons to hit (trauma) the hero.

When the Hero gets injured – Exciting Eye, and the heroine gets to know, she goes running to him, tears her dupatta to tie on his wounds and says 'chot Lagi Tujhe (U have been wounded) par dard mujhe bhi hota hai' (But I can also feel the pain) – the Sympathizing Eye

Histologic Features

Similar for both exciting eye (as this eye also develops uveitis as a result of trauma) and sympathizing eye

- Non-Necrotizing choroidal infiltration
- **Dalen Fuch nodules**: Clusters of epitheloid cells containing pigment, present between RPE and Bruch membrane.

Not Pathognomonic for Sympathetic Ophthalmitis

- Absence of inflammation of choriocapillaris and retina (differentiates it from VKH syndrome)

Clinical Features

First symptom

- Difficulty in near vision
- Photophobia

First sign

- Retrolental flare
- Keratic precipitates

Treatment

- **If no visual potential in the traumatic eye**

  ↓

  Enucleation of traumatic eye to prevent Sympathetic ophthalmitis, within 2 weeks of trauma

  Enucleation is NOT the treatment of Sympathetic ophthalmitis, it is Prevention

- If Sympathetic ophthalmitis has established

  ↓

  Systemic/periocular/Topical steroids (+) steroid sparing agents

  Resistance to only topical steroids and cycloplegics for the treatment of anterior uveitis is a diagnostic clue for sympathetic ophthalmitis

ENDOPHTHALMITIS

It is the inflammation of the inner layers (fluids and tissue) of the eyeball, **sparing Sclera**[Q].

It is a clinical diagnosis, made when intraocular inflammation involving both the anterior and posterior chambers is attributable to bacterial or fungal infections.

Causes

HIGH YIELD

Acute postoperative (within 7 days after surgery)	• Most common: *Staphyloccus epidermidis* (CONS)[Q] • *Staphylococcus aureus* • *Streptococcus*
Delayed onset postoperative/Saccular (> 6 Weeks after surgery)	• Most common – *Propionibacterium acnes*[Q] • Fungi: *Aspergillus*
Post-traumatic	Bacillus cereus
Endogenous – Bacterial • In Asia • I.V. drug abuser • DKA patients • Cutaneous infection	• Most common cause – Klebsiella[Q] • Bacillus • Mucor • Staphylococcus
Endogenous: Fungal	Candida • Cotton ball/puff ball colonies • String of pearls appearance in vitreous • Roth spots[Q]: Retinal hemorrhages with white or pale center[Q]

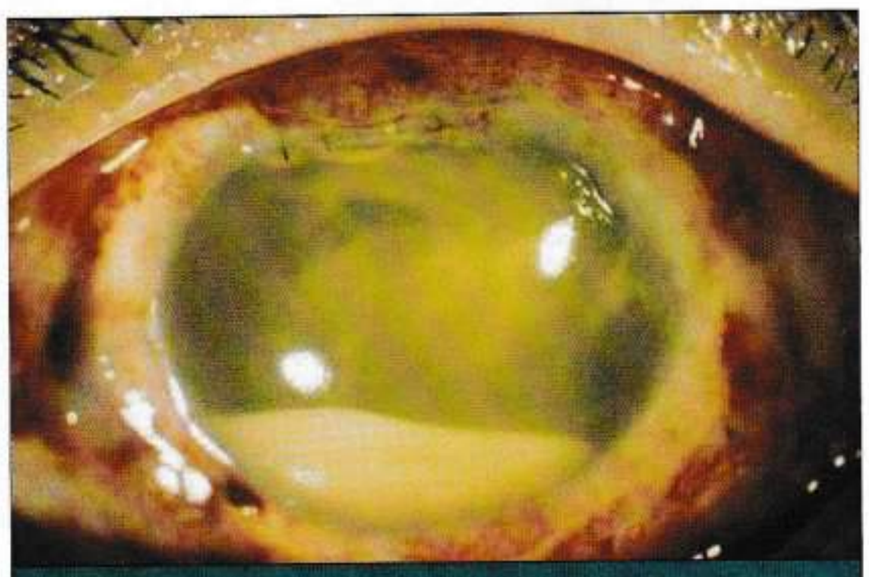
Clinical Features

Symptoms

Severe **pain**[Q], **Redness**[Q] lacrimation[Q], sudden **loss of vision**[Q]

Signs

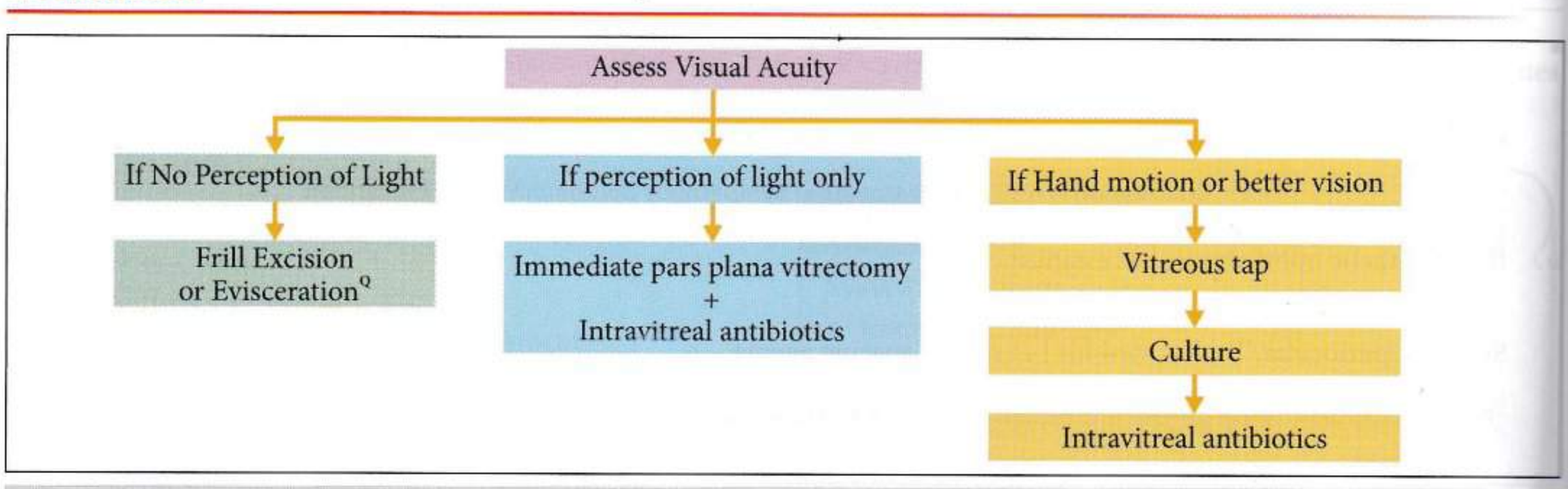
Eyelid swelling, congestion[Q], corneal edema[Q], **Hypopyon**[Q], Amaurotic cat's eye reflex (Hallmark) – due to vitreous turbidity



Endophthalmitis

Congestion, hazy cornea with hypopyon and turbidity

Treatment



Antibiotic of choice – Vancomycin (1 mg/0.1 mL) + Ceftazidime (2.25 mg in 0.1 mL)
If Fungal endophthalmitis – Voriconazole, Amphotericin B, Caspofungin

Prevention

- Povidone Iodine (5% periocular) – into the conjunctival fornices for at least 3 minutes prior to surgery is the single best method
- **Preoperative topical antibiotic use** decreases the risk.
- **Intracameral cefuroxime** should be considered in high-risk cases (i.e. Diabetes and Vitreous loss).

Systemic Antibiotics have no role in Endophthalmitis[Q]

MISCELLANEOUS

OCULAR HIV

- Ocular involvement may be the first sign of disseminated HIV infection.

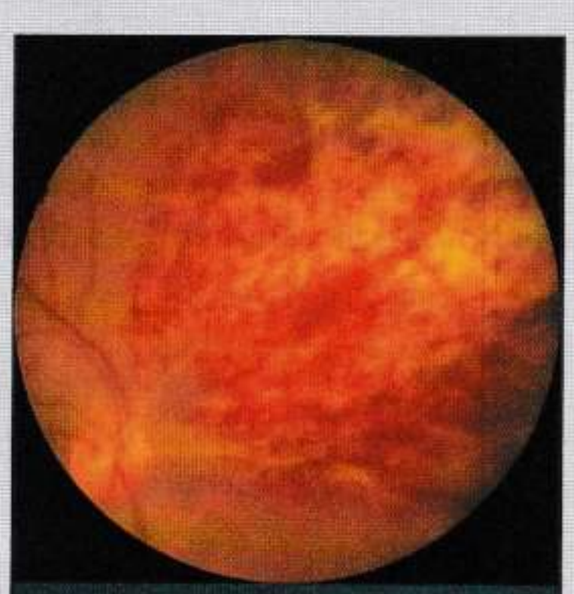
Manifestations

- HIV retinopathy[Q] – **Most common** presentation (70% cases), Non-infectious microvasculopathy
- Hemorrhages, Microaneurysms, **cotton wool spots** (**earliest sign**) can be seen
- Kaposi Sarcoma[Q] – **Most common associated tumor**
- Opportunistic infection
  - **CMV retinitis**[Q] – Most opportunistic ocular infection in HIV[Q] (CD4 ≤50 cells/μL)

Most common cause of visual morbidity[Q]
It presents with

Pizza Pie/ Scrambled egg and Ketchup appearance

Perivascular hemorrhage with exudates



Slow progressive

Brushfire extension

- Perivascular Frosted branch angitis
- Retinal detachment – most common complication

- Herpes (HSV/HZV) – present with rapidly progressing, bilateral, progressive outer retinal necrosis (PORN). It involves posterior pole, not associated with vitritis.
- Toxoplasma retinochoroiditis
- Cryptococcosis – **Most common** opportunistic fungal infection
- Molluscum contagiosum

- Primary (1°) Intraocular Lymphoma
  - Variant of Non-Hodgkin lymphoma, and has a very Poor prognosis.
  - Presents in 6th–7th decade with mild AU + Subretinal infiltrates + vitritis with CNS manifestations.
- Squamous cell carcinoma of conjunctiva.
- Adnexal Lesions - HZV, molluscum contagiosum
- Neuro-ophthalmic manifestations - Papilledema, optic atrophy and nerve palsies

Treatment

1. HAART – Use of HAART (highly active anti-retroviral therapy)
   ↓
   Immune recovery (CD4 + counts increase)
   ↓
   Associated with development of intraocular inflammation (AU + IU) causing macular edema and epiretinal membrane formation – known as Immune Recovery Uveitis
2. Anti-CMV therapy – I.V. ganciclovir, Intravitreal foscarnet

CHOROIDAL MELANOMA

- Most common intraocular malignancy in adults
- Presents Unilaterally, in the 5th–6th decade of life, most commonly post-equatorially

Choroidal melanoma (dome-shaped elevation)

Signs

- Solitary, elevated, dome-shaped mass
- Orange patches – due to clumps of lipofuscin overlying tumor
- **On B scan** – Collar stud/mushroom shape
- Exudative retinal detachment seen at the periphery of tumor.
- On FFA – Double circulation

Tumor Spread

- Penetration of Bruch membrane and RPE → herniation into subretinal space collar stud appearance
- Invasion of scleral blood vessels → orbital spread
- Invasion of vortex veins[Q] → causes Glaucoma
- Metastatic Hematogenous[Q] spread to Liver[Q] – Most common site of **metastasis**
- Rarely, optic nerve invasion

Collar stud appearance

Prognosis (Adverse Factors)[Q]

- Histologically, Epitheloid cell[Q] melanoma

Spindle cell[Q] melanoma have Best prognosis

- Size[Q] – large tumors
- Extrascleral extension – evidence of invasion[Q]
- Loss of Chromosome 3p (Monosomy 3) or Gain of chromosome 8q
- Anterior (Ciliary Body) melanomas

EXTRA MILE

Indirect ophthalmoscopy is the GOLD STANDARD investigation
Most common treatment modality – Plaque Brachytherapy
Classification – Callender's

CHOROIDAL DYSTROPHIES

- All have a POOR prognosis

	Choroideremia	Gyrate Atrophy	Generalized Choroidal Atrophy	Progressive Bifocal Chorioretinal Atrophy
Inheritance	XLR	AR	AD	AD
Age (decade)	2nd–3rd	1st–2nd	4th–5th	At birth
Symptoms	Nyctalopia	Nyctalopia Myopia	Nyctalopia Central visual loss	–
Fovea	Spared	Spared	Involved	Involved

Gyrate Atrophy

Due to mutation of gene encoding Ornithine Amino-transferase[Q]
↓
Raised ornithine levels in body fluids
↓
Treat by Arginine-restricted diet[Q] (Ornithine is synthesized from arginine)
or
Pyridoxine (vitamin B6)[Q] – Only if substitution mutation

Mnemonic

G - Gyrate atrophy
O - Ornithine AT
A, I - Arginine restriction
R - AR

SURGICAL REMOVAL OF EYEBALL

	Enucleation	Evisceration	Exenteration
Definition	Removal of the globe (whole eyeball along with the optic nerve[Q])	Removal of all the contents of eyeball except Sclera, Extraocular muscles and Optic nerve[Q]	Removal of the globe and the soft tissues of the orbit
Indications	• Retinoblastoma[Q] • Trauma	Painful, Blind eye in Endophthalmitis[Q] and Panophthalmitis	• Orbital tumors primary or metastatic • Orbital mucormycosis
Contraindication	Panophthalmitis[Q]	Malignancy[Q] – Retinoblastoma	
	Enucleated socket	Eviscerated eye Note the remaining scleral shell	Exentrated socket

...surgical removal of eye, an ocular prosthesis (usually made of silicone or acrylic) is placed,
- ...weeks—small sized prosthesis for support
- ...6 weeks—proper sized prosthesis[Q]

HIGH YIELD

HLA associations

HLA A29	Birdshot chorioretinopathy
HLA B27	Anterior Uveitis (Acute nongranulomatous)
HLA B51	Behcet's disease
HLA DR4	VKH syndrome Sympathetic ophthalmitis
HLA B8	Sarcoidosis
HLA B44	Retinal vasculitis

Cause of Cystoid Macular Edema in Uveitis

- Acute Iridocyclitis (Anterior Uveitis)
- Endophthalmitis
- Behcet's disease
- Pars Planitis
- Birdshot chorioretinopathy

Masequerade syndromes can sometimes mimic intraocular inflammation, producing signs similar to uveitis, e.g. Retinoblastoma, Leukemia, Retained Intraocular FB, Juvenile xanthogranuloma

Mnemonic

Elevated IOP in Uveitis – Causes

Pressure	–	Posner-Schlossman Syndrome
Seen	–	Sarcoidosis
Too	–	Toxoplasmosis
High	–	Herpetic Uveitis
Following	–	FHI
Glaucoma	–	2° ACG

LAST MINUTE REVISION – ONE LINERS

- Salt and pepper fundus is seen in Syphilis – (also known as Pseudo-Retinitis Pigmentosa).
- Povidone-Iodine/Betadine 5% in conjunctival sac and periorbitally is the most important to prevent endophthalimitis.
- Cells (Neutrophils) are a sign of disease activity and severity.
- There is No Pain in posterior uveitis.
- Cycloplegic drugs are not required in FHI as there are No posterior synechiae.
- Liver is the most common site of metastasis in choroidal melanoma.
- KP's are pathognomonic for AU and earliest sign is Aqueous flare.
- Snow banking is seen in Pars planitis (idiopathic intermediate uveitis).
- Ciliary body is known as dangerous area of eye.
- Pupil is Festooned (irregularly dilated) in chronic AU.
- Iris Roseolas – Syphilis
- Iris Pearls – Leprosy
- Cold Mobile Hypopyon – Behcet's syndrome
- ARLT'S Triangle – Inferiorly KP's are present.
- Stellate KP – diffuse distribution, seen in FHI and HSV uveitis
- Amsler's Sign – Fuch's heterochromic iridocyclitis
- White eye – JIA
- ARN – HSV, PORN-VZV (most common) or HSV in HIV
- Candle wax drippings, Lander's sign—Sarcoidosis
- String of pearls appearance—Sarcoidosis and Candida infection
- Pizza pie appearance/scrambled egg and ketchup, Brushfire, frosted branch angitis—CMV retinitis
- Staphylococcus epidermidis—Most common cause of acute postoperative endophthalmitis.
- Pilocarpine and latanoprost are contraindicated for IOP control in hypertensive uveitis.
- Koeppe nodules are present at the pupillary margin.
- Toxoplasma causes focal, necrotizing retinochoroiditis and granuloma, headlight in fog appearance.

IMAGE-BASED QUESTIONS

There are multiple probable questions that can be asked on a single image.
Question numbers 1 to 4 are based on Image 1.

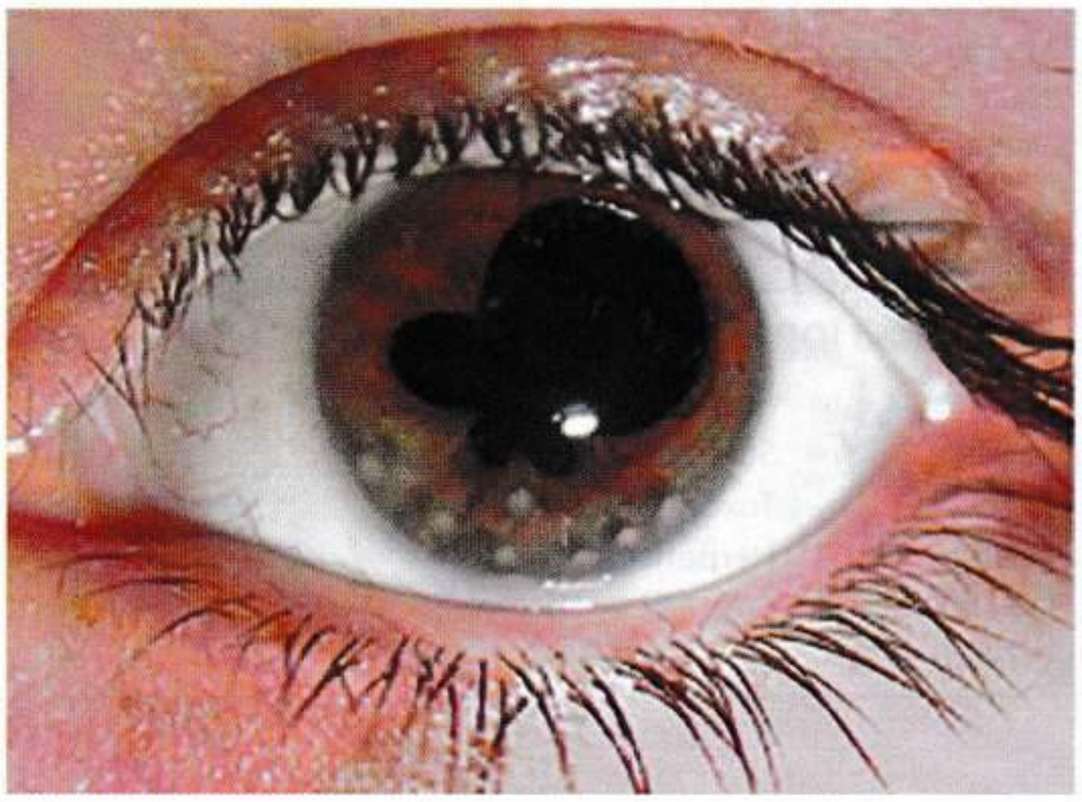


Image 1

1. **All of the following can be seen in the above photograph except**
   a. Seclusio pupillae
   b. Festooned pupil
   c. Keratic precipitates
   d. Posterior synechiae
2. **All of the following are true about the above patient except**
   a. Keratic precipitates are usually seen inferiorly
   b. Aqueous flare is always a sign of acute uveitis
   c. Aqueous cells are an indicator of disease activity
   d. Iris nodules are always seen in chronic uveitis
3. **The drug of choice for the patient with the findings in the above photograph is**
   a. Ketorolac
   b. Periocular Triamcinolone
   c. Atropine
   d. Tropicamide
4. **The patient in the above photograph is a 33 year old female. On systemic examination she is found to have hilar lymphadenopathy and dry cough. What is the most likely cause?**
   a. Vogt Koyanagi Harada syndrome
   b. Sarcoidosis
   c. Ankylosing spondylitis
   d. Tuberculosis

Question number 5 is based on Image 2.

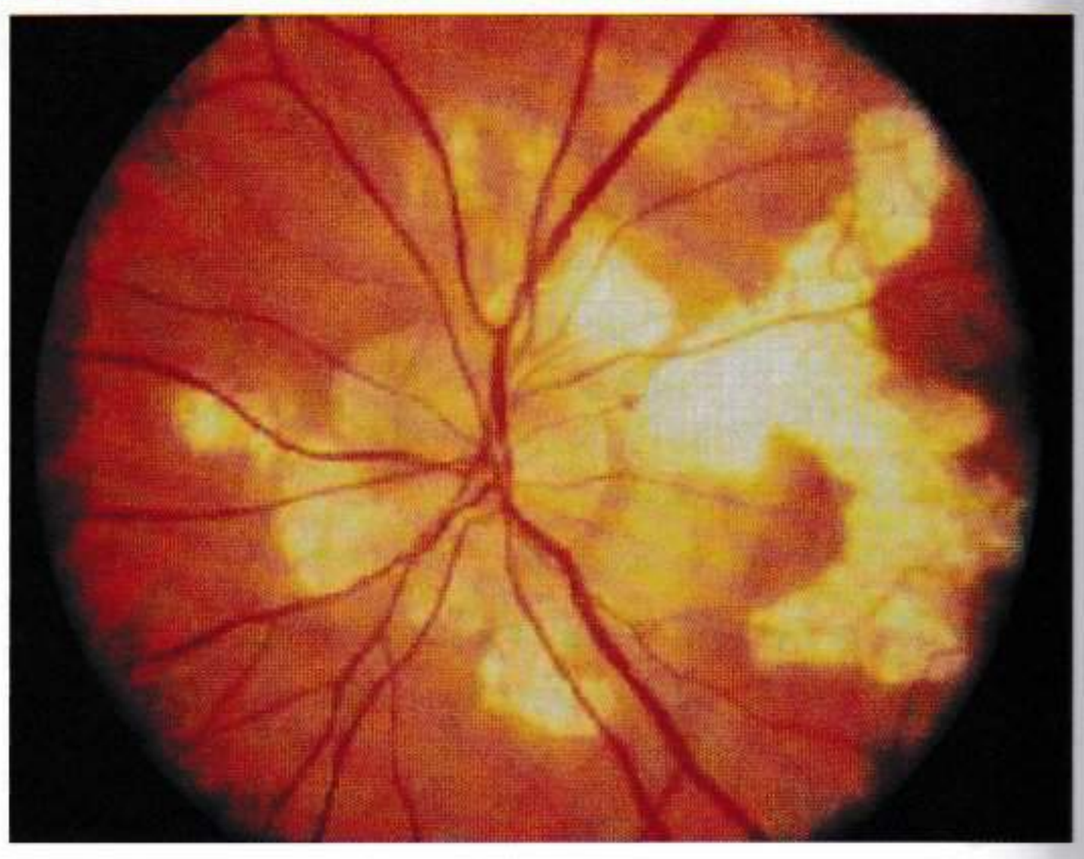


Image 2

5. **Identify the posterior segment pathology.**
   a. Geographic helicoid choroidopathy
   b. Cystoid macular edema
   c. Sarcoidosis
   d. Purtscher retinopathy

Question numbers 6 to 8 are based on Image 3.

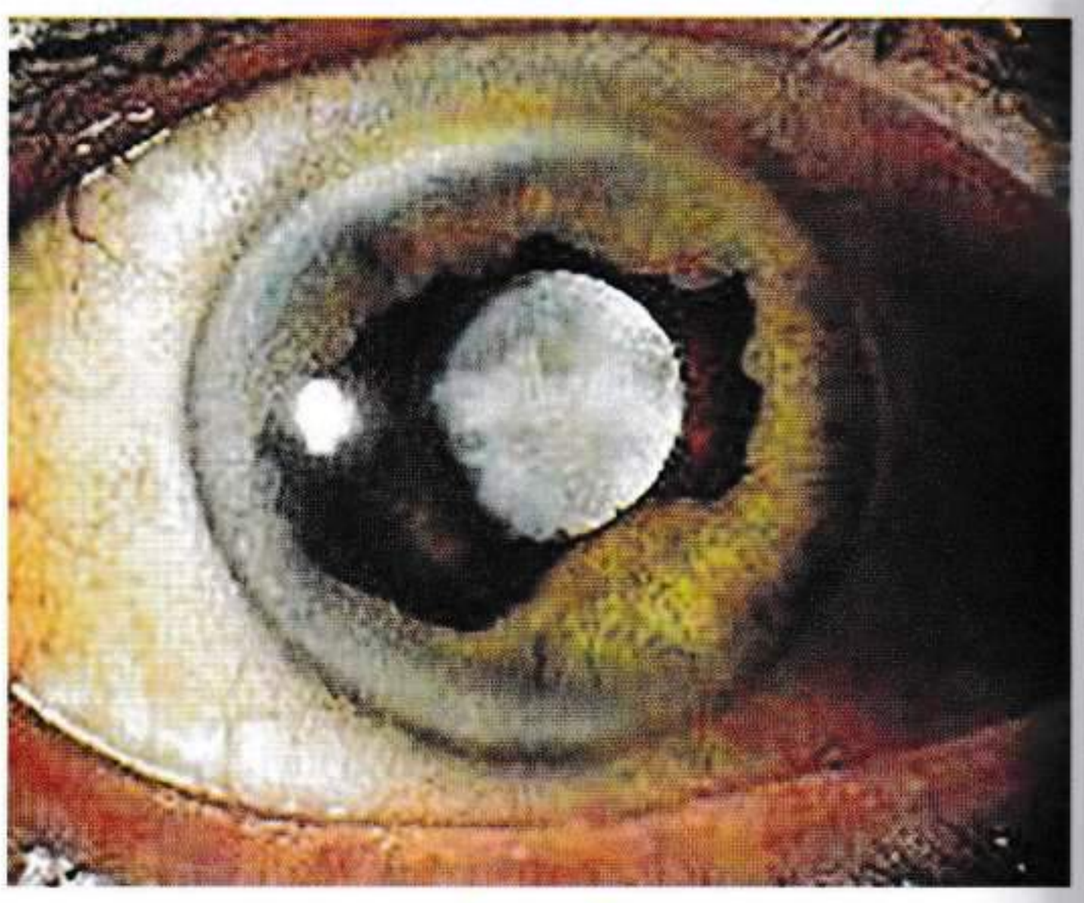


Image 3

6. **What are the signs visible in the anterior segment photograph?**
   a. Cataract
   b. Iris nodules
   c. Ectropion Uveae
   d. Corneal ulcer

7. **All of the following can lead to the above condition except**
   a. Iris tumors
   b. Iris neovascularization
   c. Prader-Willi syndrome
   d. Neurofibromatosis II

8. **All of the following are true about the congenital pathology seen in image except**
   a. It is mostly hereditary and bilateral
   b. It is associated with Axenfeld-Rieger syndrome
   c. Secondary open angle glaucoma with high iris insertion is associated
   d. Goniotomy is not successful

Question number 9 is based on Image 4.

Image 4

9. ***All of the following are possible causes for the anterior segment condition (image) in the above patient except***
   a. Latanoprost use in the left eye
   b. Fuch's Heterochromic iridocyclitis in the left eye
   c. Rubeosis iridis in the left eye
   d. Left eye Nevus of Ota

Question number 10 is based on Image 5.

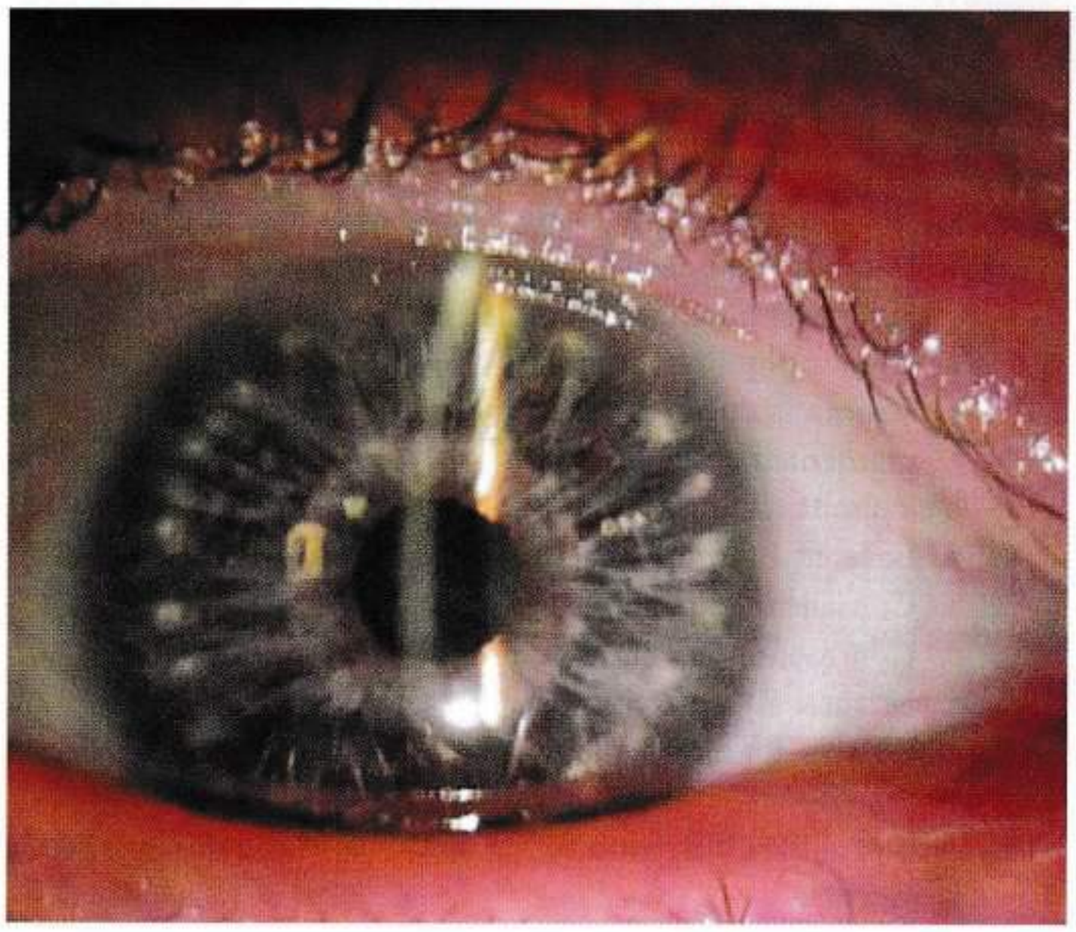


Image 5

10. **Identify the ocular pathology.**
    a. Brushfield spots
    b. Kunkmann-Wolffian bodies
    c. Down syndrome
    d. All of the above

Question number 11 is based on Image 6.

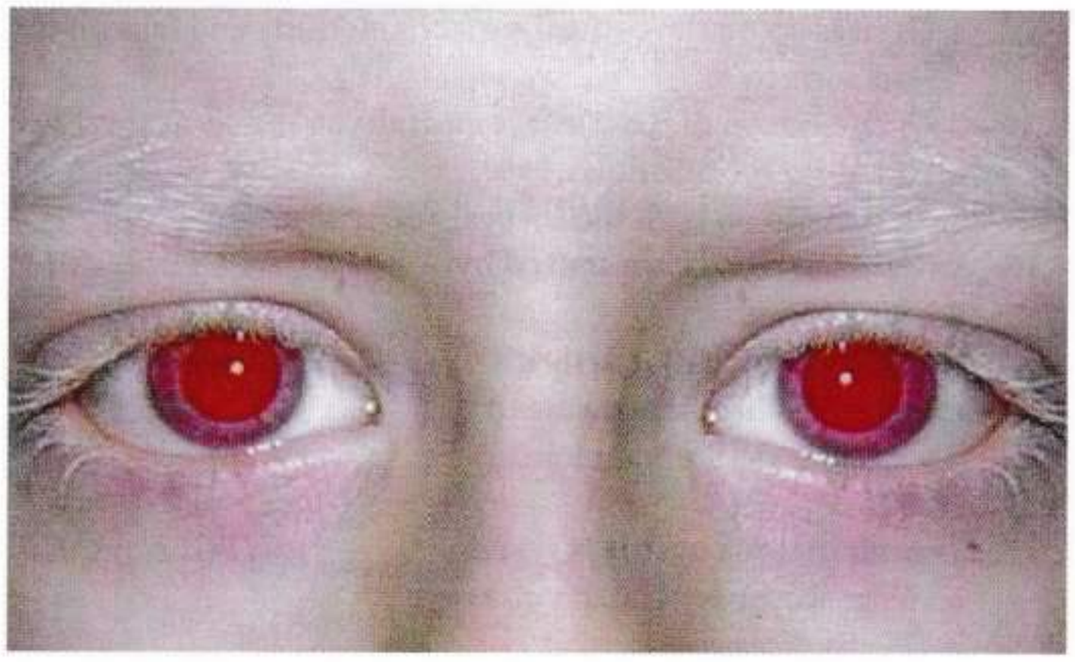


Image 6

11. **A 4-year-old child presents with visual acuity 6/60 and nystagmus in both the eyes. Clinical picture is given below. What is the possible diagnosis?**
    a. Oculocutaneous albinism
    b. Pseudo-exfoliation syndrome
    c. Acute anterior uveitis
    d. Hermansky-Pudlak syndrome

MULTIPLE CHOICE QUESTIONS

Anatomy

12. True about iris: *(PGI May 2016)*

a. Eye colour is due to relative number of melanocytes
b. Stroma is responsible for pigmentation
c. Sphincter pupillae is supplied by parasympathetic fibers
d. Dilator pupillae is supplied by sympathetic fibers
e. Stroma is covered on its anterior surface by two layers of pigmented epithelium

13. True about ciliary body: *(PGI May 2013)*

a. Located 10 mm from corneoscleral junction
b. Consists of pars plana and pars plicata
c. Contraction of ciliary body helps in accommodation
d. Secretes aqueous humor
e. Derives its blood supply from the short posterior ciliary arteries

14. Uvea provides nutrition to *(AIIMS May 2008)*

a. Cornea
b. Rod and cone cells
c. Ganglion cell layer of retina
d. Inner aspect of sclera

Anterior Uveitis

15. The convection current of aqueous has the following direction of flow *(AIIMS May 2010)*

a. It rises up on the corneal surface anteriorly and falls on the iris surface
b. It rises up on the iris surface and falls on the corneal surface
c. It has no specific flow
d. It rises up on both the corneal and iris surface

16. Anterior uveitis is/are caused by: *(PGI May 2013)*

a. Sarcoidosis
b. Juvenile idiopathic arthritis
c. Juvenile chronic arthritis
d. Juvenile xanthogranuloma
e. TB

17. Granulomatous uveitis is seen in : *(PGI Nov 2010)*

a. Vogt-Koyanagi-Harada disease
b. Fuch's disease
c. Behçet's syndrome
d. Sarcoidosis
e. Psoariasis

18. All are causes of chronic granulomatous uveitis except– *(Recent pattern Nov/Dec 2016)*

a. Sarcoidosis
b. Tuberculosis
c. Brucellosis
d. Fuchs heterochromic iridocyclitis

19. Most common cause of anterior uveitis associated with arthritis– *(Recent pattern Dec 2012, AIIMS Dec 1998)*

a. Ankylosing spondylitis
b. Rheumatoid arthritis
c. Syphilis
d. Tuberculosis

20. Uveitis is associated most commonly associated with– *(AIIMS May 2002)*

a. Rheumatoid arthritis b. Systemic JRA
c. Pauciarticular JRA d. Polyarticular JRA

21. Granular keratic precipitates are made of *(Recent pattern Nov/Dec 2016)*

a. Epitheloid cells b. Macrophages
c. Lymphocytes d. RBC

22. Which of the following indicates activity of anterior uveitis– *(Recent pattern 2015)*

a. Cells in anterior chamber
b. Circumcorneal congestion
c. Keratic precipitate
d. Corneal edema

23. Red keratic precipitates are seen in– *(Recent pattern Dec 2013)*

a. Granulomatous uveitis
b. Hemorrhagic uveitis
c. Old healed uveitis
d. Acute anterior uveitis

24. Nodules seen near the collarette are called– *(Recent pattern Nov/Dec 2016)*

a. Busacca's nodules
b. Koeppe's nodules
c. Lisch nodules
d. Dalen Fuch's nodules

25. Histological changes in lens induced uveitis include– *(Recent pattern Dec 2014)*

a. Ghost cells
b. Giant cell reaction
c. Amyloid in the cornea
d. Vasculitis

26. Posner-schlossman syndrome is– *(Recent pattern Nov/Dec 2016)*

a. Ipsilateral optic atrophy with contralateral papilledema
b. Unilateral glaucomatous changes with mild anterior uveitis
c. Granulomatous uveitis with iris heterochromia
d. None of the above

27. Iris bombe is seen in which disease? *(Recent pattern Nov/Dec 2016)*

a. Uveitis b. Conjunctivitis
c. Episcleritis d. Trachoma

28. Which of the following causes uveitis with vitiligo and deafness? *(Recent pattern 2014)*

a. Sturge weber syndrome
b. Centurion syndrome
c. Alezzandrini syndrome
d. Vogt koyanagi harada syndrome

29. Muddy appearance of iris is seen in? *(Recent pattern Nov/Dec 2016)*

a. Glaucoma
b. Iridocyclitis
c. Persistent pupillary membrane
d. Iris cyst

Most Recent Questions of 2019-2017 are given at the end

30. **In patients with anterior uveitis, decrease in vision due to posterior segment involvement can occur because of:** *(AIIMS May 2012)*
   a. Visual floaters
   b. Inflammatory disc edema
   c. Exudative retinal detachment
   d. CME

31. **Recurrent mobile hypopyon seen in Acute anterior Uveitis indicates?** *(Recent pattern 2016)*
   a. Behçet's Syndrome
   b. Reiter's Syndrome
   c. Enteropathic Uveitis
   d. Ankylosing spondylitis

32. **A young patient presents to the ophthalmic outpatient department with gradual blurring of vision in the left eye. Slit lamp examination reveals fine stellate keratatic precipitates and aqueous flare and a typical complicated posterior subcapsular cataract. No posterior synechiae were observed. The most likely diagnosis is:** *(All India 2012)*
   a. Intermediate Uveitis (Pars Plantis)
   b. Heerfordt's disease
   c. Heterochromic Iridocyclitis of Fuch's
   d. Subacute Iridocyclitis

33. **Not feature of Fuchs' heterochromic iridocyclitis:** *(PGI May 2016)*
   a. White nodules on the anterior surface of the iris
   b. Keratic precipitates present at back of cornea
   c. Granulomatous type of low grade anterior uveitis
   d. Topical corticosteroids are used for treatment

34. **A 10 yr boy present with bilateral chronic uveitis. Which investigation should be ordered :** *(PGI May 2010)*
   a. Hemogram
   b. X-ray of sacroiliac jt.
   c. HIV test
   d. Mantoux test

35. **You are an intern on emergency night duty in ophthalmology ward. A patient complaints of sudden painful loss of vision. What is the best sign to differentiate Acute Anterior Uveitis from Acute Angle closure Glaucoma?** *(Recent pattern 2016)*
   a. Circumcorneal congestion
   b. Keratic precipitates
   c. Posterior synechiae
   d. Miosis

36. **In HLA B27 associated disease which of the following is seen** *(Recent pattern 2016)*
   a. Acute granulomatous anterior uveitis
   b. Posterior uveitis
   c. Acute nongranulomatous anterior uveitis
   d. Chronic nongranulomatous anterior uveitis

37. **Koeppe nodules are seen in** *(Recent pattern 2016)*
   a. Anterior granulomatous uveitis
   b. Pars planitis
   c. CMV retinitis
   d. Chorioretinitis

38. **Iris nodules are seen in all except**
   a. Leprosy
   b. Syphilis
   c. Juvenile Xanthogranuloma
   d. Sturge-Weber syndrome

39. **Tyndall phenomenon is used in the visualization of**
   a. Keratic precipitates
   b. Trabecular meshwork
   c. Aqueous flare
   d. Posterior synechiae

40. **A 30 yr old male patient presented with anterior granulomatous uveitis, arthralgia and respiratory difficulties. What is the most probable diagnosis?** *(AIIMS Nov 2009)*
   a. Ocular sarcoidosis
   b. HLA B27 uveitis
   c. Tuberculosis
   d. Behcet's syndrome

41. **What is the most common eye manifestation of allergy to tubercular bacilli?** *(State PG)*
   a. Koeppe's nodules
   b. Posterior scleritis
   c. Phlyctenular conjunctivitis
   d. Optic neuritis

42. **Iridocyclitis is a feature of**
   a. Juvenile rheumatoid arthritis with systemic involvement
   b. Seropositive, pauciarticular, juvenile rheumatoid arthritis
   c. Seronegative, pauciarticular, juvenile rheumatoid arthritis
   d. Seropositive, polyarticular juvenile rheumatoid arthritis

43. **Insidious iritis is seen in**
   a. TT type of leprosy
   b. LL type of leprosy
   c. Herpes zoster ophthalmicus
   d. Burnt out case of leprosy

44. **Iris roseolas are seen in**
   a. Sarcoidosis
   b. Syphilis
   c. Leprosy
   d. Tuberculosis

45. **Iris pearls are pathognomonic for** *(Recent pattern Nov/Dec 2016)*
   a. Leprosy
   b. Syphilis
   c. Sarcoidosis
   d. Herpes simplex virus

46. **Uveoparotitis is seen in which of the following disorders**
   a. Scleroderma
   b. Syphilis
   c. Sarcoidosis
   d. SLE

47. **True about *phthisis bulbi*:** *(PGI Nov 2016)*
   a. Size of eye decreases
   b. Removed by enucleation operation
   c. IOP increases in late stage
   d. Calcification may occur in Bowman's layer of cornea

48. **Which of the following statements is incorrect about phthisis bulbi?** *(All India 2006)*
   a. The intraocular pressure is increased
   b. Calcification of the lens is common
   c. Sclera is thickened
   d. Size of the globe is reduced

49. **Phthsis bulbi means–** *(Recent pattern 2016)*
   a. Developmental hypoplasis of optic cup
   b. Final end stage of chronic scleritis
   c. Final end stage of chronic uveitis
   d. All of the above

50. **Uveitis is/are seen as side-effect of caused by:** *(PGI Nov 2014)*
   a. Latanoprost
   b. Moxifloxacin
   c. Cidofovir
   d. Rifabutin

Most Recent Questions of 2019-2017 are given at the end

Posterior Uveitis

51. A young adult presented with diminished vision. On examination he has anterior uveitis, viritis, focal necrotizing granuloma, macular spot. What is the most probable diagnosis? *(AIIMS May 2012)*

a. Proteus syndrome
b. White dot syndrome
c. Multifocal chorioditis
d. Ocular toxoplasmosis

52. Which of the following protozoan affects the eye? *(AIIMS Nov 2012)*

a. E. histolytica
b. E. coli
c. Giardia lambia
d. Toxoplasma

53. True about Birdshot Chorioretinopathy? *(Recent pattern 2016)*

a. Unilateral
b. Bilateral
c. Acute onset
d. Most commonly seen in males

54. Candle wax dripping type of vasculitis is a feature of *(Recent pattern July 2016)*

a. Behcet's syndrome
b. TB uveitis
c. Traumatic uveitis
d. Sarcoidosis

55. Jensen's choroiditis is *(DNB 2011)*

a. Peripheral choroiditis
b. Juxtapapillary choroiditis
c. Disseminated choroiditis
d. None of the above

56. In ocular toxocariasis *(PGI May 2016)*

a. A history of visceral larva migrans is always present
b. Examination of the patient's stool is useful in diagnosing the disease
c. Bilateral ocular involvement should make one doubt the accuracy of the diagnosis
d. Ultrasound of the granuloma typically shows calcification
e. Oral thiabendazole is useful

57. Photopsia is seen in *(JIPMER 2016)*

a. Iridocyclitis
b. Central serous retinopathy
c. Tractional retinal detachment
d. Choroiditis

58. An individual infected with HIV has a necrotizing retinitis on fundus examination. Which of the following will be most helpful to make a diagnosis?

a. Serologic testing for herpes virus, including CMV
b. Mantoux test
c. Vitreous biopsy
d. Blood culture for herpes virus, including CMV

59. Headlight in fog appearance is characteristic for *(Recent pattern 2016)*

a. Toxoplasmosis
b. Candia endophthalmitis
c. Sarcoidosis
d. CMV retinitis

Panuveitis

60. A 20 year old man complaints of reading difficulty in his right eye 5 weeks after a gunshot injury to his left eye. The most likely diagnosis is

a. Retinal detachment
b. Vitreous hemorrhage
c. Corneal ulcer
d. Sympathetic ophthalmitis

61. Which of the following is k/a dangerous zone of eye *(All India 2003)*

a. Optic nerve
b. Ciliary body
c. Sclera
d. Retina

62. True about sympathetic ophthalmitis: *(PGI May 2012)*

a. Occur after trauma and surgery
b. Injured eye is exciting eye
c. Occur in sound eye immediately
d. Bilateral non-suppurative uveitis occur

Endophthalmitis

63. Endophthalmitis involves inflammation of all of the following, Except- *(All India 2010)*

a. Sclera
b. Uvea
c. Retina
d. Vitreous

64. Late onset endophthalmitis after cataract surgery is most often caused by: *(All India 2011)*

a. Staphylococcus Epidermidis
b. Pseudomonas
c. Streptococcus Pyogenes
d. Propionibacterium Acnes

65. A 60 year old diabetic patient has an uneventful phacoemulsification with IOL implantation. He presented with pain, diminution of vision, redness, watering and a grayish yellow pupillary reflex on the third postoperative day. Examination revealed circumorneal congestion, aqueous cells 4+, hypopyon in the anterior chamber with posterior synechiae and retrolental flare. The most likely diagnosis is: *(All India 2012)*

a. Keratitis
b. Glaucoma
c. Endophthalmitis
d. Postoperative cyclitis

66. Which anti-fungal is used intraviterally? *(Recent pattern 2014)*

a. Fluconazole
b. Amphotericin B
c. Itraconazole
d. Flucytosine

67. A vitreous aspirate from a case of metastatic endophthalmitis on culture yields Gram positive round to oval cells, 12-14 Ã– in size. The aspirate on Gram staining shows the presence of pseudohyphae. Which of the following is the most likely etiological agent?

a. Aspergillus
b. Rhizopus
c. Candida
d. Fusarium

Treatment

68. Which of the following is *not used topically for ophthalmic use*?

a. Hydrocortisone
b. Prednisolone
c. Methylprednisolone
d. Dexamethasone

69. In which of the following uveitic conditions is it contraindicated to put an intraocular lens after cataract surgery? *(All India 2006)*

a. Fuch's heterochromic cyclitis
b. Juvenile rheumatoid arthritis
c. Psoriatic arthritis
d. Reiter's syndrome

Most Recent Questions of 2019-2017 are given at the end

70. **Which of the following is not used as local injection for ophthalmic use?** *(Recent pattern 2014)*
   a. Triamcinolone b. Prednisolone
   c. Methylprednisolone d. Dexamethasone

71. **Chronic use of systemic steroids most commonly leads to which ocular complication?** *(Recent pattern 2013)*
   a. Cataract b. Glaucoma
   c. Uveitis
   d. Conjuctival and lid papillomatosis

72. **Drug used in LUMINATE programme for non infectious uveitis is:** *(AIIMS Nov 2011)*
   a. Voclosporin b. Methotrexate
   c. Infliximab d. Cyclosporine

73. **Primary objective of use of atropine in anterior uveitis–** *(AIIMS June 2000)*
   a. Rest of the ciliary muscle
   b. Increase supply of antibody
   c. Increase blood flow
   d. Prevents posterior synechia formation

74. **Mainstay of treatment of uvieitis–** *(Recent pattern 2014)*
   a. Antibiotics and cycloplegics
   b. Steroids and cycloplegics
   c. Antibiotics and steroids
   d. Surgery

Miscellaneous

75. **Persistent pupillary membrane originates from** *(Recent pattern Nov/Dec 2016)*
   a. Collarette b. Angle of ant. chamber
   c. Around pupil d. Root of iris

76. **Snow banking is typically seen in–** *(Recent pattern 2014)*
   a. Pars planitis b. Endophthalmitis
   c. Coat's disease d. Eale's disease

77. **Choroidal neurovascularization is seen in all except–** *(AIIMS May 08)*
   a. Trauma b. Angoid streak
   c. Myopia d. Hypermetropia

78. **Which of the following is not an indication for evisceration?** *(AIIMS May 2015)*
   a. Malignancy b. Panophthalmitis
   c. Severe globe trauma d. Expulsive hemorrhage

79. **A patient is suffering from gyrate atrophy of choroid which is due to the deficiency of enzyme Ornithine aminotransferase. Which of the following is beneficial for the patient?** *(AIIMS May 2012)*
   a. Ornithine free diet
   b. Arginine free diet
   c. Folic acid and pyridoxine supplementation
   d. Vitamin B6, B12 supplementation

80. **Pseudouveitis is seen in**
   a. Toxoplasmosis b. Malignant melanoma
   c. Retinoblastoma d. Sarcoidosis

81. **The use of HAART is associated with the development of**
   a. Retinitis b. Choroiditis
   c. Uveitis d. Keratitis

82. **The commonest cause of visual loss in AIDS is which one of the following** *(Recent pattern 2016)*
   a. Toxoplasmosis b. Herpetic retinitis
   c. CMV retinitis d. HIV retinitis

83. **Which of the following is the most accurate method of diagnosing CMV retinitis?**
   a. Viral antibody detection in blood by ELISA
   b. Isolation of viral particles from aqueous humor
   c. Nucleic acid amplification from aqueous samples
   d. Viral antigen detection from vitreous sample

84. **What is *reverse hypopyon*?**
   a. Collection of pus in the anterior chamber
   b. Collection of emulsified silicone oil in the anterior chamber
   c. Collection of pus in the posterior chamber
   d. Presence of air bubble in the posterior chamber

85. **Which of the following is not of prognostic significance in choroidal melanoma?** *(AIIMS May 2006)*
   a. Presence of retinal detachment
   b. Size of the tumor
   c. Cytology of the tumor
   d. Presence of extraocular inflammation

86. **Intractable secondary glaucoma is seen in:** *(All India 2008)*
   a. Diffuse iris melanoma
   b. Nodular iris melanoma
   c. Melanocytic deposits in anterior part of iris
   d. Melanocyte proliferation in posterior uveal tissue

87. ***Uveal Effusion syndrome may* be associated with all of the following, Except** *(All India 2009)*
   a. Myopia b. Ciliochoroidal detachment
   c. Structural defect in Sclera
   d. Nanophthalmos

88. **Ocular dendritic cells have:** *(AIIMS May 2012)*
   a. HLA I b. HLA II
   c. Both d. None

89. **Which of the following is the most common fungal infection of the eye seen in an HIV positive patient?** *(AIIMS Nov 2015)*
   a. Aspergillus b. Candida
   c. Toxoplasma d. Rhinosporidium

Most Recent Questions of 2019-2017

90. **Keratic precipitates are seen in which layer of the cornea?** *(Recent pattern 2017)*
   a. Corneal epithelium b. Descemet's membrane
   c. Corneal endothelium d. Bowman's membrane

91. **Hypervirulent Klebsiella pneumoniae causes?** *(Recent pattern 2017)*
   a. Endophthalmitis b. Uveitis
   c. Keratitis d. Glaucoma

92. **Commonest opportunistic organism to cause ocular inflammation in AIDS is** *(Recent question June 2018)*
   a. Cytomegalovirus
   b. Herpes simplex virus
   c. Toxoplasmosis
   d. Candida albicans

93. **Which of the following ocular changes are usually not seen in an AIDS patient** *(Recent question June 2018)*
   a. Papillodema
   b. Cotton wool spots
   c. Retinal microaneurysms
   d. Hard exudates

Most Recent Questions of 2019-2017 are given at the end

ANSWERS TO IMAGE-BASED QUESTIONS

1. Ans. (a) Seclusio pupillae

Option a – after recurrent attacks of iritis, the whole pupillary margin becomes adherent with the lens capsule, known as Ring synechiae or Seclusio papillae.
(In the photo synechiae are absent supero-temporally.)
Option b – When posterior synechiae are localized (as in this photo), mydriatic causes intervening portions of circle to dilate; the pupil assumes an irregular 'Festooned' appearance.
Option c – Keratic precipitates are lymphocytic (inflammatory cells) collections on the corneal endothelium.
Option d – Adhesion of the pupillary margin (iris) to the lens capsule.

2. Ans. (b) Aqueous flare is always a sign of acute uveitis

Option a – KP are cellular deposits on the corneal endothelium composed of epitheliod cells, lymphocytes and polymorphs.
They are more numerous inferiorly and may form a triangular pattern with the apex pointing up (Arlt's triangle). This is the result of gravity and normal aqueous convection.
Option b – Aqueous flare is seen in both acute and chronic cases.
Option c – Aqueous cells indicate disease activity and their number reflects disease severity.
Option d – fact

3. Ans. (c) Atropine

Option a – NSAIDS are an adjunct to corticosteroids and can be used topically or as systemic drugs. They are useful for cases of very mild diffuse episcleritis or postoperative pseudophakic Cystoid macular edema.
Option b – Periocular corticosteroids are given as depot injections, preferably in patients with intermediate or posterior uveitis.
Option c/d – Mydriatic and cycloplegic drugs are the mainstay as
- Beneficial for breaking or preventing the formation of posterior synechiae
- Relieving photophobia secondary to ciliary spasm

Atropine ointment is the most commonly used parasympatholytic agent.

4. Ans. (b) Sarcoidosis

Option b – The combination of bilateral hilar lymphadenopathy, erythema nodosum and arthralgia is a sign of Sarcoidosis – Lofgren syndrome. It is primarily an interstitial lung disease thus causing dry cough. It also causes Granulomatous anterior Uveitis.
The combination of anterior uveitis, parotitis, VII cranial nerve paralysis and fever is called uveoparotid fever or Heerfordt syndrome.
Option a – VKH syndrome affects the skin, meinges, ear and causes panuveitis.
Option c – Ankylosing Spondylitis causes non-granulomatous acute uveitis, and does not cause hilar lymphadenopathy.
Option d – TB is the most likely differential diagnosis in this patient, but dry cough tilts the answer.

5. Ans. (a) Geographic helicoid choroidopathy

6. Ans. (a) Cataract; and (c) Ectropion Uveae

Option a – any opacification of the lens is known as Cataract. In the above photo mature to Hypermature cataract can be seen.
Option b – iris nodules cannot be seen, neither at the pupillary margin nor in the stroma.
Option c – Ectropion uveae - eversion of the posterior pigmented epithelium of the iris at the pupillary margin, thus, due to it, pigmentation can be seen on the anterior surface of iris.
Option d – cornea is seen to be normal.

7. Ans. (d) Neurofibromatosis II

Causes of ectropion uveae have been asked.
- Associated with NF 1 and **not** NF 2
- Seen in 1% cases of Prader-Willi syndrome
- Most commonly associated with melanoma and Iris Nevus
- In acquired cases, associated with cases of rubeosis iridis
- Posterior polymorphous corneal dystrophy (PPMD)
- Progressive iris atrophy

8. Ans. (a) It is mostly hereditary and bilateral

It may be a case of Congenital ectropion uveae with Congenital cataract.
Option a – it is a rare non hereditary unilateral condition.
Option b - Corectopia, polycoria, ectropion uveae, posterior embryotoxon, and increased intraocular pressure are common ophthalmologic findings with Axenfeld Reiger syndrome (Refer chapter 1).
Option c – On goniscopy a high iris insertion, incomplete development of the trabecular meshwork and the Schlemm's canal is seen, thus leading to Secondary open angle glaucoma.
Option d – as the Trabecular meshwork and Schlemm's canal are both maldeveloped, Goniotomy has no role, and Trabeculectomy is the procedure of choice to treat the glaucoma.

9. Ans. (b) Fuch's Heterochromic iridocyclitis in the left eye

In the image, left iris is seen to be darker than the right eye. i.e. Left Hyperchromic Heterochromia or Right Hypochromic Heterochromia.

Heterochromia iridis

- **Hyperchromic**
  - Idiopathic
  - Iris naevus (Ota) or melanoma
  - Rubeosis iridis
  - Siderosis
  - Xanthochromia from hyphema
  - Unilateral use of Latanoprost[Q]
  - Incontinentia pigmenti
- **Hypochromic**
  - Idiopathic
  - Congenital Horner's syndrome
  - Trauma or surgery
  - Fuch's heterochromic iridocyclitis[Q]
  - Piebaldism
  - Hirschsprung disease

10. Ans. (d) All of the above

Ref: Parson's 22/e, p. 121

Kunkmann-Wolffian bodies are hypopigmented areas of peripheral iris stromal hyperplasia in patients without **Down syndrome**.

They are clinically indistinguishable from **Brushfield spots** which are seen in individuals with **Down syndrome**.

11. Ans. (a) Oculocutaneous albinism

Ref: Parson's 22/e, p. 259; Kanski 7/e, p. 682-683

Group of disorders of melanin synthesis which affect the eye, hair and skin.

Signs:

- Pink eye – due to absence of pigment in iris
- Visual acuity – poor due to foveal hypoplasia
- Nystagmus, strabismus and photophobia
- High myopia
- Large choroidal vessels seen in fundus
- White hair and very pale skin

ANSWERS TO MULTIPLE CHOICE QUESTIONS

12. Ans. (a) Eye color is due... (b) Stroma is responsible... (c) Sphincter pupillae, (d) Dilator pupillae is supplied by sympathetic fibers

Ref: Khurana Anatomy and Physiology 2/e, p. 45; Parson's 22/e, p. 8

"***Eye color is determined by the relative number of melanocytes in the stroma*** and anterior limiting layer (which is a condensed part of stroma)

The stroma is covered on its posterior surface by two layers of pigmented epithelium

13. Ans. (b) Consists... (c) Contraction... & (d) Secretes...

Ref: Khurana 5/e, p. 142-43

- The **ciliary body has three basic functions**: *aqueous production and removal, accommodation, and the formation of vitreous mucopolysaccharide.*
- The *anterior margin of the ciliary body is at the scleral spur*, and thus 1.5 mm posterior to the corneal limbus in the horizontal meridian and 2 mm posterior in the vertical meridian.
- The arterial supply to the ciliary body is via the *long posterior ciliary and anterior ciliary arteries.*

14. Ans. (b) Rods and cone cells

Ref: Khurana anatomy 2/e, p. 45

Uvea provides nutrition to the outer one-third of retina.

15. Ans. (b) It rises up on the iris surface and falls on the corneal surface

Ref: Sunita Agarwal, volume 1, p. 59

Due to iris vascularity, aqueous rises up against the hot surface, and due to the corneal avascularity, aqueous falls down against the cold corneal surface

16. Ans. (a) Sarcoidosis (b) Juvenile.. & (c) Juv.. & (e) TB

Ref: Parson's 20/e, p. 225

17. Ans. (a) Vogt.. & (d) Sarc..

Ref: Khurana 4/e, p. 141; Parson's 20/e, p. 235-37

18. Ans. (d) Fuchs heterochromic iridocyclitis

Ref: Parson's 21/e, p. 229

19. Ans. (a) Ankylosing spondylitis

Ref: Essentials of ophthalmology 2/e, p. 195

- ***Child → JRA is the most common cause***
- ***Young adults → HLB-27 associated uveitis (Ankylosing spondylitis is the most common cause)***
- ***Older adults → Idiopathic anterior uveitis is most common.***

20. Ans. (c) Pauciarticular JRA

Ref: Ghai pediatrics 5/e, p. 428

21. Ans. (c) Lymphocytes

Ref: Khurana 6/e, p. 154

22. Ans. (a) Cells in anterior chamber

Ref: Parson's 22/e, p. 120

23. Ans. (b) Hemorrhagic uveitis

Ref: Parson's 22/e, p. 616

- Red KPs are seen in hemorrhagic uveitis.

24. Ans. (a) Busacca's nodules

Ref: Khurana 6/e, p. 156

25. Ans. (b) Giant cell reaction

Ref: www.mcrcophth.com/mcq1.htm, Test I (for final FRCOphth/ MRCOphth)

- Lens-induced uveitis is giant–cell granulomatous uveitis.

26. Ans. (b) Unilateral glaucomatous changes with mild anterior uveitis

Ref: Parson's 22/e, p. 238

27. Ans. (a) Uveitis

Ref: Khurana 6/e, p. 156; Parson's 22/e, p. 236

Annular posterior synechiae (ring synechiae are 360° adhesions of pupillary margin to anterior capsule of lens. These prevent the circulation of aqueous humor from posterior chamber to anterior chamber (seclusio pupillae). Thus, the aqueous collects behind the iris and pushes it anteriorly (leading to ***'iris-bombe' formation***)

28. Ans. (d) Vogt koyanagi harada syndrome

Ref: Parson's 22/e, p. 251

29. Ans. (b) Iridocyclitis

Ref. Parson's 22/e, p. 122, 236

In anterior uveitis (Iridocyclitis) the pupil is constricted, its reactions are sluggish, and the delicate pattern of the iris, instead of being clear and sharphy defined, becomes blurred and indistinct ('muddy' iris)

30. Ans. (d) CME

Ref: Lange ophthalmology by Vaughan & Asbury 17/e

"Cystoid macular edema is a common cause of visual loss in patients with uveitis and may be observed in the setting

of severe anterior or intermediate uveitis. Long-standing or recurrent macular edema can cause permanent loss of vision due to cystoid degeneration."

31. Ans. (a) Behcet's Syndrome

Ref: Kanski 8/e, p. 398; Parson's 22/e, p. 251

32. Ans. (c) Heterochromic Iridocyclitis of Fuch's

Ref: Kanski 7/e, p. 469; Yanoff 3/e, p. 865

The complications from chronic inflammation in FHI do not include posterior synechiae or cystoid macular edema unlike other anterior uveitis.

33. Ans. (c) Granulomatous type of low...

Ref: Parson's 22/e, p. 300; Kanski 7/e, p. 469

- Fuchs' heterochromic iridocyclitis is a chronic *nongranulomatous type* of low grade anterior uveitis.

34. Ans. (a) Hemogram

Ref: Parson's 20/e, p. 225; American Academy of Ophthalmology Section 6/p. 311

Traditionally, posterior uveitis has been thought to account for 40%-50% of uveitis cases in children; anterior uveitis, 30%-40%; intermediate uveitis, about 20% and panuveitis, less than 10%.

In many cases, uveitis in children is idiopathic, but juvenile idiopathic arthritis (JIA) is the most common identifiable underlying systemic disease. Infections including toxoplasmosis, toxocariasis, and herpes viruses are relatively common in children with uveitis.

Hemogram is advisable to rule out infectious pathologies
Anti-nuclear antibodies tested to diagnose JIA/JCA.

35. Ans. (d) Miosis

Ref: Kanski 7/e, p. 402

In acute cases of anterior uveitis pupil is usually constricted – Miosed whereas in acute angle closure glaucoma pupil is found to be Vertically oval, mid-dilated and fixed.

36. Ans. (c) Acute nongranulomatous anterior uveitis

Ref: Kanski, 7/e, p. 416

37. Ans. (a) Anterior granulomatous uveitis

Ref: Kanski, 7/e, p. 405

38. Ans. (d) Sturge-Weber syndrome

Option a/b/c - Iris nodules are typically seen in cases of granulomatous uveitis[Q] caused by Sarcoidosis, TB, Syphilis, Leprosy, VKH syndrome, Lyme disease, Brucellosis, Multiple sclerosis, Juvenile xathogranuloma, Fuchs heterochromic iridocyclitis,
Option d - Iris nodules (Lisch) can also be seen in Neurofibromatosis 1, but not in other Phakomatoses

39. Ans. (c) Aqueous flare

Ref: Khurana, 6/e, p. 155

40. Ans. (c) Tuberculosis

Option b/d – cause non-granulomatous uveitis
Option a – Sarcoidosis presents either as Lofgren syndrome (Erythema nodosum, bilateral hilar lymphadenopathy, iritis) or Heerfordt syndrome (Uveoparotid fever)
Option c – TB causes granulomatous uveitis and the systemic findings are consistent with it.

41. Ans. (a) Koeppe's nodules

Ref: AAO, p. 257-259; Kanski, p. 450-452

- The most common eye manifestation of allergy to tubercular bacilli is chronic granulomatous Uveitis – Koeppe nodules are a sign of it
- Disseminated choroiditis is the most common presentation
- Most common etiology of Phlyctenular conjunctivitis is tuberculosis.

42. Ans. (c) Seropositive, pauciarticular, juvenile rheumatoid arthritis

Ref: Kanski 7/e, p. 416-420; Parson's 22/e, p. 250

43. Ans. (b) LL type of leprosy

Ref: bmj.com; Kanski, 7/e, p. 457

44. Ans. (b) Syphilis

Ref: Wills Eye Manual 6/e, p. 360; Parson's 22/e, p. 246

45. Ans. (a) Leprosy

Ref: Khurana 6/e, p. 164

Iris pearls are seen as glistening white beads at the pupillary margin. These lesions are composed of bacilli (dead bacteria) within histiocytes and are Pathognomic for Lepromatous uveitis.

46. Ans. (c) Sarcoidosis

Ref: Parson's 22/e, p. 251

Heerfordt syndrome also known as Uveoparotid fever is caused by Sarcoidosis.

47. Ans. (a) Size of eye decrease; (b) Removed by enucleation..., (d) Calcification may occur ...

Ref: Yanoff ocular pathology 7/e, p. 65–66; Khurana 6/e, p. 158

Phthisis bulbi

- It is the ***final stage end result of any form of chronic uveitis***.
- The globe is non-functioning thus the patient is blind in that eye. ***Enucleation +/- prosthesis insertion*** is performed if there is associated chronic pain or for cosmetic reasons.

End Stage of Diffuse Ocular Diseases

- **Atrophy without shrinkage**
  - Atrophy of intraocular structures such as the retina and uvea in a normal-size or even enlarged eye (e.g. buphthalmos).
  - The best example is the *diffuse atrophy with long-standing glaucoma*.

- **Atrophy with shrinkage (atrophia bulbi)**
  - This refers to atrophy of intraocular structures, which remain recognizable, plus atrophy of the globe so that it is **smaller than normal**.
  - The best example is chronic, long-standing uveitis (especially when it starts in childhood) that goes on to phyotomy in the presence of an anterior chamber angle closed by peripheral anterior syncchiae.
  - Clinically, the eye is soft and partially collapsed. The pull of the horizontal and vertical recuts muscles causes the shrunken eye to appear cuboid ('squared-off') instead of spherical when viewed with the lids widely separated. A soft, squared-off atrophic eye when seen clinically is called a phthisical eye or a phthisis bulbi.
  - Histologically, however, the eye does not usually show phthisis buibi (See later) but, rather, atrophia bulbi.
- **Atrophy with shrinkage and disorganization (phthisis bulbi)**
  - Markedly **thickened sclera and atrophy of intraocular structures** sufficiently profound to make them **unrecognizable**.
  - Histologically
    - Disorganization
    - Calcification in Bowman's layer
    - Intraocular ossification

48. Ans. (a) The intraocular pressure is increased

49. Ans. (c) Final end stage of chronic uveitis

50. Ans. (a) Latanoprost; (c) Cidofovir & (d) Rifabutin

Ref: Parson's 22/e, p. 156-57, 235; KDT 7/e, p. 772, 801; Becker Shaffer glaucoma 8/e, p. 366, Yanoff and Ducker 8/e, p. 773

- "Uveitis have been reported with rifabutin" *(KDT 7/e, p. 772)*
- "Cidofovir: Uveitis is side effect" *(KDT 7/e, p. 801)*
- Incidence of anterior unities during latanoprost treatment was 5–6% in one retrospective trial, with case being bilateral (It is an idiosyncratic reaction)-Becker-Shaffer Glaucoma

51. Ans. (d) Ocular toxoplasmosis

Ref: Kanski 7/e, p 429, 457, 459

- The word for clinching the diagnosis is **FOCAL. In ocular toxoplasmosis the most common lesion is the focal necrotizing retinitis and necrotizing granuloma**
- In multifocal choroiditis, granulomatous lesions are not found, and the lesions are multifocal instead of focal
- White dot syndrome is not a single disease entity but it a group of disorders comprise of various inflammatory clinical entities, (APMPPE), Birdshot retinochoroidopathy, (PIC), (MEWDS). Obviously, dots are multiple (multifocal rather than focal)
- Proteus syndrome (PS) is a hamartomatous disorder

52. Ans. (d) Toxoplasma

Ref: Yanoff 3/e, Chapter 7.12 Ocular, Toxoplasmosis; Harrison 18/e, p. 1724

Toxoplasmosis is the most common cause of posterior uveitis and accounts for approximately 90% of focal necrotizing retinitis.

53. Ans. (b) Bilateral

Ref: Kanski, 7/e, p. 467; Khurana 6/e, p. 170

Birdshot chorioretinopathy is an uncommon idiopathic chronic/recurrent bilateral disease which predominantly affects females. Over 95% patients are positive for HLA A29. The disease involves both the retina and choroid independently.

54. Ans. (d) Sarcoidosis

Refer text

55. Ans. (b) Juxtapapillary choroiditis

Ref: Parson's, 22/e, p. 238-239

Choroiditis is usually classified according to the number and location of areas involved

- Disseminated /diffuse
- Multifocal
- Central
- Juxtapapillary (of Jensen)

56. Ans. (c) Bilateral ocular involvement should make one doubt the accuracy of the diagnosis

Ref: American Academy of Ophthalmology, BSCS, Section 9/ p. 235-236

Option a – ocular toxocariasis and VLM rarely present at the same period of time
Option b – as the worm doesnot complete its life cycle in human (completed in dogs or cats), examination of the stool is not helpful
Option c – bilateral cases have not been reported, IT IS ALWAYS UNILATERAL
Option d – calcification is not seen
Option e – inflammation is due to reaction to the worm and therefore Steroid and NOT thibendazole should be given

57. Ans. (d) Choroiditis

Ref: Parson's, 22/e, p. 239; Kanski 7/e, p. 459

Option c – Photopsia seen only in rhegmatogenous RD
Option d – Photopsia is a symptom in inflammatory choroiditis like PIC, AWEDS, MFC etc., and is mostly due to direct stimulation of the afferent visual pathways - causing irritation of rod and cone cells.

58. Ans. (c) Vitreous biopsy

A necrotizing retinitis in an HIV patient – most likely to be an infectious cause (viral or parasitic –Toxoplasmosis)
Option a/d – blood culture and serologic testing do not prove an intraocular infection, they are helpful only in ruling out the possibility of a viral infection
Option b – due to anergy, unreliable
Option c – Vitreous biopsy is the most specific way to determine the cause.

59. Ans. (a) Toxoplasmosis

Ref : Kanski 7/e, p. 430

60. Ans. (d) Sympathetic ophthalmitis

Ref: Kanski 7/e, p. 465

61. Ans. (b) Ciliary body

Ref: Anatomy in Surgery 3/e, p. 79

Penetrating trauma to ciliary body can lead to development of bilateral Panuveitis, known as sympathetic ophthalmitis and thus known as dangerous area of eye.

62. Ans. (a) Occur.., (b) Injured.. & (d) Bilateral …

Ref: Parson's 20/e, p. 374-76; Kanski 7/e, p. 465

A serious bilateral granulomatous (non-suppurative) panuveitis which follows a penetrating ocular trauma. The *injured eye is called exciting eye and the fellow eye which also develops uveitis is called sympathizing eye*. Very rarely, sympathetic ophthalmitis can also occur following an intraocular surgery.

63. Ans. (a) Sclera

Ref: Khurana, 6/e, p. 170

64. Ans. (d) Propionobacterium Acnes

Ref: Parson's 22/e, p. 241-242

65. Ans. (c) Endophthalmitis

Ref: Yanoff 3/e, p. 491; Kanski 7/e, p. 290

Painful red eye with diminution of vision along with evidence of aqueous flare, hypopyon and loss of normal red reflex, three days after cataract surgery suggests a diagnosis of acute postoperative endophthalmitis.

Acute postoperative endophthalmitis generally develops within 2–5 days of surgery[Q] and has fulminant course

Vitreous becomes purulent as shown by a yellow reflex with oblique illumination—Parson's 21/e, p. 236

66. Ans. (b) Amphotericin B

Ref: Kanski 7/e, p. 449; Roy and Fraunfelder's Current Ocular Therapy p. 476

Intravitreal amphotericin B (5 mg in 0.1 mL) for endophthalmitis.

Voriconazole (intravitreal, oral or intravenous) may be used to treat cases resistant to oral fluconazole

67. Ans. (c) Candida

Ref: Kanski 7/e, p. 449

Candida endophthalmitis

- **Candida albicans is the most common fungal organism causing endogenous endophthalmitis**
- Chorioretinits
  - Bilateral, multiple, small (<1mm) well circumscribed lesions, post equatorial
- Vitritis
  - Vitreous – **string of pearls appearance**
- **Histologically, budding yeasts with characteristic pseudohyphate pattern**

Option b/d – do not cause endogenous endophthalmitis

Option a – septate, dichotomous hyphae

68. Ans. (c) Methylprednisolone

Ref: American Academy of Ophthalmology, BCSC, Section 9/p. 101

Corticosteroids frequently used in uveitis therapy and their complications

Route of Administration	Relative anti-inflammatory activity*	Complications
Topical		Cataract (posterior subcapsular), elevation of IOP/ glaucoma, exacerbation of external infection (eg, keratitis), corneal and scleral thinning or melting, delayed wound healing
Prednisolone acetate 1%	2.3	
Prednisolone sodium phosphate 1%	2.3	
Fluorometholone 0.1%	21	
Dexamethasone phosphate 0.1%	24	
Rimexolone 1%		
Loteprednol etabonate 0.5% or 0.2%		
Difluprednate 0.05%		
PERIOCULAR		Same complications as topical above and; Ptosis, scarring of conjunctiva/Tenon capsule, worsening of infectious uveitis, scleral perforation, hemorrhage
Long-acting		
Methylprednisolone acetate	5.0	
Triamcinolone acetonide	5.0	
Triamcinolone diacetate	5.0	
Short-acting		
Hydrocortisone sodium succinate	1.0	
Betamethasone	25	
INTRAOCULAR		Same complications as topical above and: Endophthalmitis (sterile or infectious), vitreous hemorrahage, retinal detachment
Triamcinolone(preservative-free) 4 mg/0.1 mL		
Systemic		Same complications as topical above and: increased appetite, weight gain, peptic ulcers, sodium and fluid retention, osteoporosis/bone fractures, diabetes mellitus, menstrual irregularities, mental status changes, exacerbation of systemic infections, impaired wound healing, acne, many others
Prednisone	4.0	
Triamcinolone	5.0	
Dexamethasone	25	
Methylprednisolone	5.0	

*Numbers represent relative anti-inflammatory activity compared to that of hydrocortisone.

69. Ans. (b) Juvenile rheumatoid arthritis

Ref: American academy of ophthalmology, BSCS, Section 9/p. 131

Treatment of cataracts in patient with JIA remains a challenge, and the **use of IOLs remains controversial**. There is a high complication rate following cataract surgery in patients with JIA- associated iridocycitis, due to the difficulty in controlling the more aggressive inflammatory response seen in these children. Lensectomy and vitrectomy via the pars plana have been advocated. Ben Ezra and Cohen studied 5 children with JIA who received IOL implants. Although the vision initially improved in 4 of 5 eyes, it later decreased due to the development of retrolental membranes.

The following **guidelines** must be followed when selecting patients with JIA for cataract surgery with IOL implants:

- The patient's **intraocular inflammation** must be **well controlled for at least 3 months** before surgery with systemic IMT and must not require frequent instillation of topical corticosteroids.
- Only **acrylic lenses should be implanted**
- Patients must be **followed up very frequently after** cataract surgery to detect any inflammation, and inflammation that occurs must be aggressively treated.
- IMT must be used preoperatively and postoperatively, not just perioperatively

Several authors have warned against IOL implantation in children with JRA-associated uveitis and cataract.'- Cataract surgery in Children with Chronic Uveitis Opthalmology. 200 Jul; 107 (7): 1255-60

70. Ans. (b) Prednisolone

Ref: American Academy of Ophthalmology, BSCS, Section 9/p. 101

71. Ans. (a) Cataract

Ref. Khurana 4/e, p. 428

Injudicious use of systemic steroids leads to following ocular complication:

- **Cataract**
- Delayed wound healing
- Infections of eye
- Papilloedema
- CRVO
- **Glaucoma is more often associated with topical ocular or periocular steroids**

72. Ans. (a) Voclosporin

Ref: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2699819/ Clin Ophthalmol. 2008 December; 2(4):693–702

- Voclosporin is a next-generation **calcineurin inhibitor**
- The LUMINATE (Lux Uveitis Multicenter Investigation of a New Approach to Treatment) clinical development program was initiated in 2007 to assess the safety and efficacy of voclosporin for the treatment, maintenance, and control of all forms of **non-infectious uveitis**
- Not FDA approved

73. Ans. (a) Rest of the ciliary muscle

Ref: Uveitis Update by David Benezra 1/e, p. 167-168

- Atropine is used for all the given four objectives.
- However, the primary objective of atropine is to relieve ciliary spasm and give rest to ciliary muscles.

74. Ans. (b) Steroids and cycloplegics

Ref: Parson's 22/e, p. 240-241

75. Ans. (a) Collarette

Ref: Paediatric Ophthalmology by Wright and Speigel, p. 444

PPM is the most common developmental abnormality of the iris. They are believed to thevestiges of precursor vessels and associated structures derived from tunica vasculosa lentis.

The formation of a PPM is a normal embryological process and starts at the Iris Collarette (thickest part of the iris).

76. Ans. (a) Pars planitis

Ref: Khurana 4/e, p. 161

77. Ans. (d) Hypermetropia

Ref: Yanoff & Duker 2/e, p. 919–920

78. Ans. (a) Malignancy

Ref: Kanski 7/e, p. 116

Malignancy (retinoblastoma) needs to enucleated, as the most common route of spread is direct through the optic nerve and sclera and in evisceration sclera is not removed.

79. Ans. (b)>(c), (d)

Ref: Yanoff and Duker 4/e, p. 574, Kanski 7/e, p. 670

Treatment is aimed[Q] at reducing the plasma ornithine levels

- Administration of Vitamin B6 (pyridoxine), 15 to 20 mg/day is beneficial in only a small subgroup of patients
- Arginine free diet – studies have suggested that it may cause a decrease in the progression of chorioretinal degeneration.

80. Ans. (b) Malignant melanoma

Ref: American Academy of Ophthalmology, BCSC, Section 281/ p. 289; Parson's 22/e, p. 252

A necrotizing malignant melanoma may present with **Masquer**, in which tumor presents with inflammatory signs which is mistaken to be a case of endogenous uveitis, and thus, pseudouveitis.

Other cause:

- Acute leukemia
- Juvenile xanthogranuloma
- Lymphoma
- Anterior segment ischemia

81. Ans. (c) Uveitis

Ref: Kanski 7/e, p. 444

Use of HAART (highly active anti retroviral therapy)

↓

Immune recovery (CD4+ counts increase)

↓

Associated with development of intraocular inflammation causing macular edema and epiretinal membrane formation (Immune recovery Uveitis)

82. Ans. (c) CMV retinitis

Ref: Kanski, p. 442; John Hopkins HIV guide p. 60

CMV retinitis is the most common[Q] opportunistic ocular infection amongst patients with AIDS and is the most common cause of Visual morbidity[Q]

83. Ans. (c) Nucleic acid amplification from aqueous samples

Ref: Yanoff and Duker, 4/e, p. 705-707

PCR based nucleic acid amplification and detection is the best method for diagnosis of CMV retinitis.

84. Ans. (b) Collection of emulsified silicone oil in the anterior chamber

Ref: webeye.ophth.uiowa.edu/ eyeforum/ atlas/ pages/reverse-hypopyon/index.htm

Silicone oil used in vitreoretinal surgeries may escape via pupil into the anterior chamber if correct posture is not maintained by the patient. It collects superiorly in the anterior chamber as compared to hypopyon which collects inferiorly, and is thus known as Reverse hypopyon or Hyperoleon.

85. Ans. (a) Presence of retinal detachment

Ref: Kanski 7/e, p. 505

86. Ans. (a) Diffuse iris melanoma

Ref: Surgical Pathology of Head & Neck p. 1935

Intractable secondary glaucoma may also occur in cases of blunt trauma due to anteriorly dislocated lens setting caught in the pupil.

Iris melanoma
(malignant neoplasms that arise from neurorectodermal melanocytes with in the Iris)

Circumscribed/nodular iris melanoma
- Present as pigmented spot on the iris
- These tumors are usually localized, well circumscribed and nodular
- These tumors usually tend to involve only a limited segment of the angle circumference and hence glaucoma is less common and usually treatable

Diffuse iris melanoma
- Present as a unilateral dark iris (**hyperchromic heterochromia**)[Q]
- These tumors show a flat and diffuse infiltration pattern of growth
- The infiltration invades the intertrabecular spaces and plugs the drainage mechanism, resulting in an intractable secondary glaucoma

87. Ans. (a) Myopia

Ref: 'The Eye' by Forrester, Dick and Lee 2/e, p. 188; Parson's 22/e, p. 254

Uveal Effusion Syndrome (Ciliochoroidal Effusion)

Uveal effusion syndrome is an **idiopathic** disease of the retina and choroid characterized by abnormal accumulation of serous fluid in the outer layer of ciliary body or choroid

Clinical Features

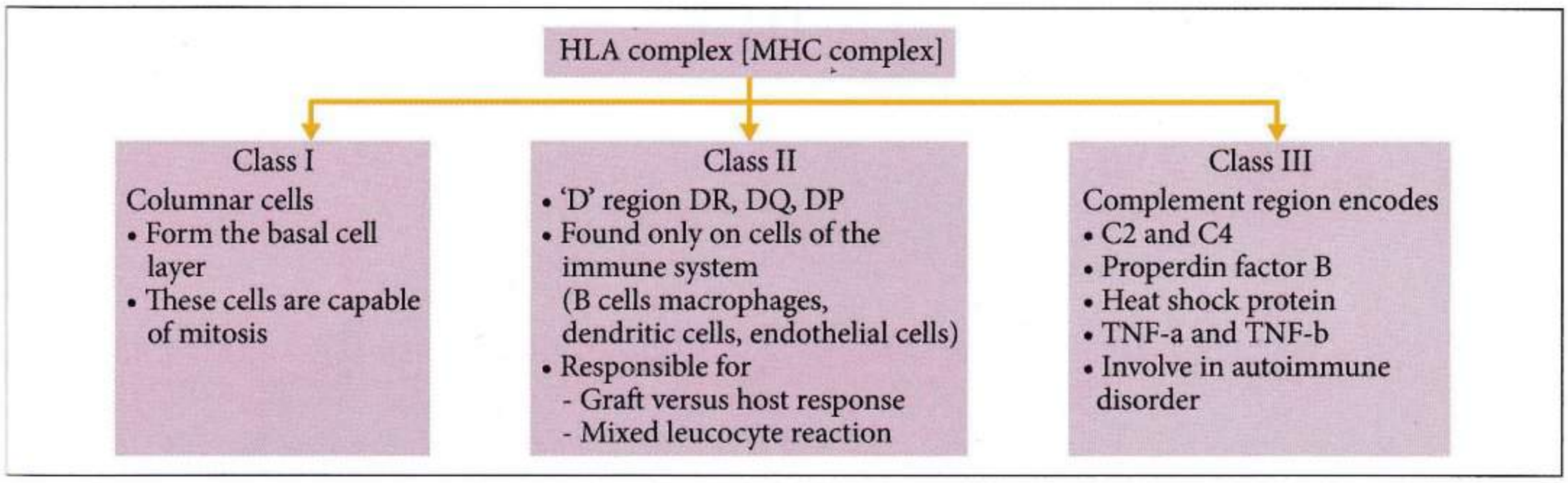
- **Structurally abnormal sclera** (Thick Sclera)
- Abnormal accumulation of serous fluid in the outer layer of ciliary body and choroid
  - Detachment of Ciliary body (Exudative)
  - Detachment of Choroid (Exudative)
  - Detachment of Retina (Exudative)

  ] **Deep Ciliochoridal detachments**
- Absence of inflammation or neoplastic disease
- **Eyes maybe nanopthalmic (small) or hypermetropic**
  Phthisis and hypotonia is usually due to ciliary body shutdown from chronic detachment which compromises the blood supply to the ciliary processes
- Mottling of pigment Epithelium (Leopard spots) may be seen after spontaneous resolution

88. Ans. (b) HLA II

Ref: Yanoff & Duker 3/e, Chapter 7.2

- HLA complex of genes is located on the short arm of chromosome 6
  - It consists of there separate clusters of genes


HLA complex [MHC complex]
Class I
Columnar cells
• Form the basal cell layer
• These cells are capable of mitosis
Class II
• 'D' region DR, DQ, DP
• Found only on cells of the immune system (B cells macrophages, dendritic cells, endothelial cells)
• Responsible for
- Graft versus host response
- Mixed leucocyte reaction
Class III
Complement region encodes
• C2 and C4
• Properdin factor B
• Heat shock protein
• TNF-a and TNF-b
• Involve in autoimmune disorder

89. Ans. (b) Candida

Ref: Robbins and Cotran, E book, p. 253

Candidiasis is the most common fungal infection in patients with AIDS.

90. Ans. (c) Corneal endothelium

Ref: Kanski 7/e, p. 405

KP's are clusters of cellular deposits on the corneal endothelium composed of epitheliod cells, lymphocytes and polymorphs.

91. Ans. (a) Endophthalmitis

Ref: Kanski 7/e, p. 455

Endogenous endophthalmitis occurs when organisms enter the eye through the blood-ocular barrier. The most common agent is Klebsiella species.

92. Ans. (a) Cytomegalovirus

Ref: Kanski 7/e, p. 442; Parson's 22/e, p. 247

93. Ans. (d) Hard exudates

Ref: Parson's 22/e, p. 539

NOTES

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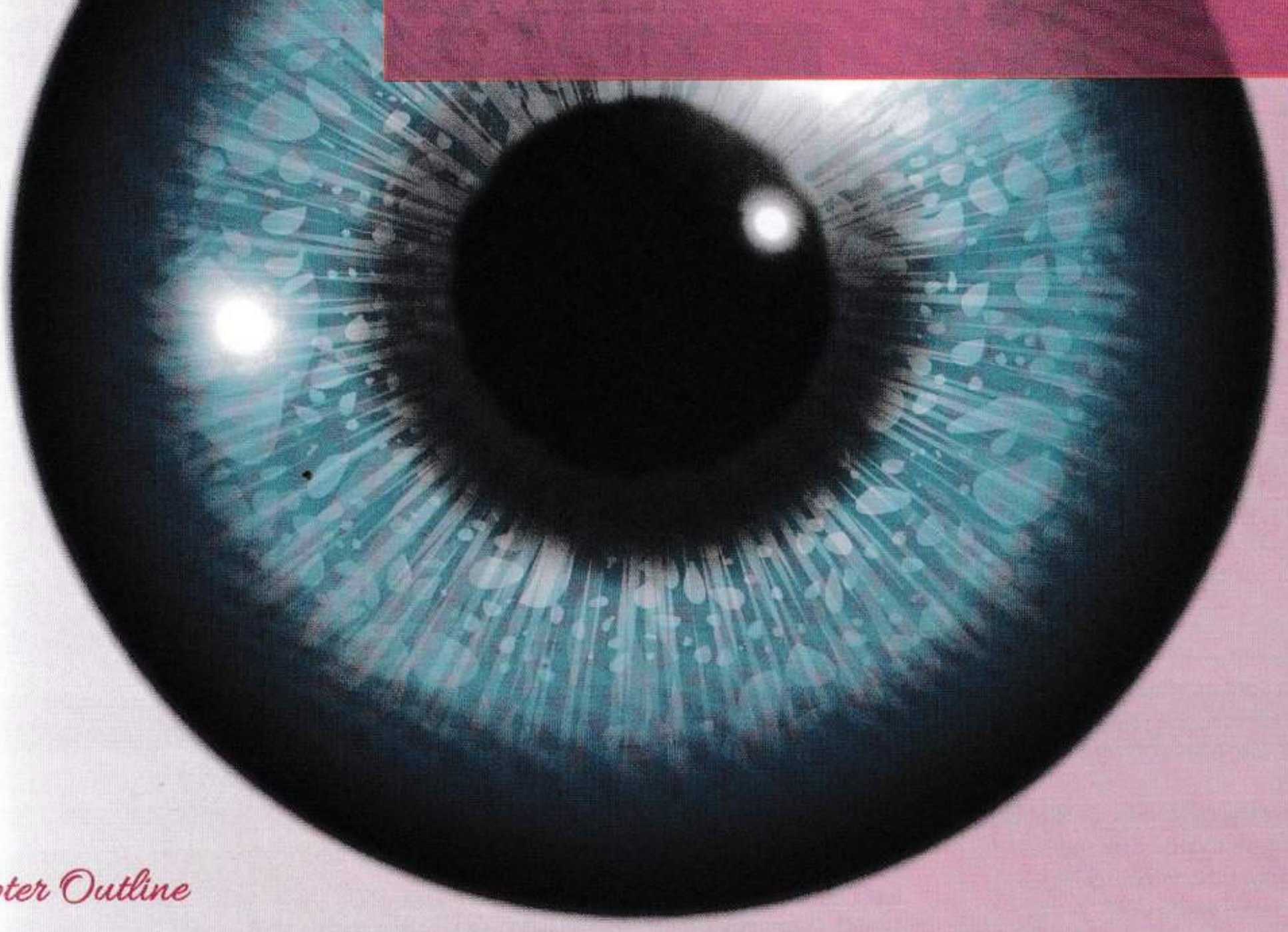
8

RETINA



Chapter Outline

Anatomy
- Gross
- Layers

Clinical Examination
- Ophthalmoscopy
- B-scan USG
- Fundus Fluorescein Angiography
- ERG
- EOG

Vascular Retinal Disorders
- Diabetic Retinopathy
- Hypertensive Retinopathy
- CRVO
- CRAO
- Retinopathy of Prematurity

Acquired Macular Disorders
- Central Serous Retinopathy
- Cystoid Macular Edema
- Age-Related Macular Degeneration

Hereditary Fundus Dystrophies
- Retinitis Pigmentosa

Retinal Detachment

Retinoblastoma

"I am responsible for what you perceive, not what you see.
Yet
The perception of what a thing is and the perception of what it means in visual form are not separate, either."

ANATOMY

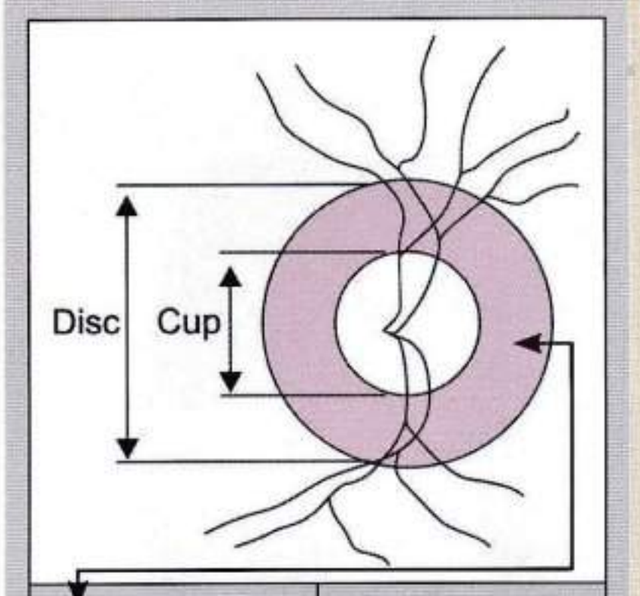
Retina is the **innermost** coat of the eyeball and is clinically visible as a **transparent** membrane on fundus examination.

It extends from the optic disc posteriorly (0.56 mm thick) to the ora serrata anteriorly (0.1 mm thick)

Gross Anatomy

Optic Disc (OD)

- It is the first (**intraocular**) part of the optic nerve – also known as the optic nerve head.
- Color: Pale pink
- Shape: Vertically oval
- **Diameter:** 1.5 mm or 1500 microns

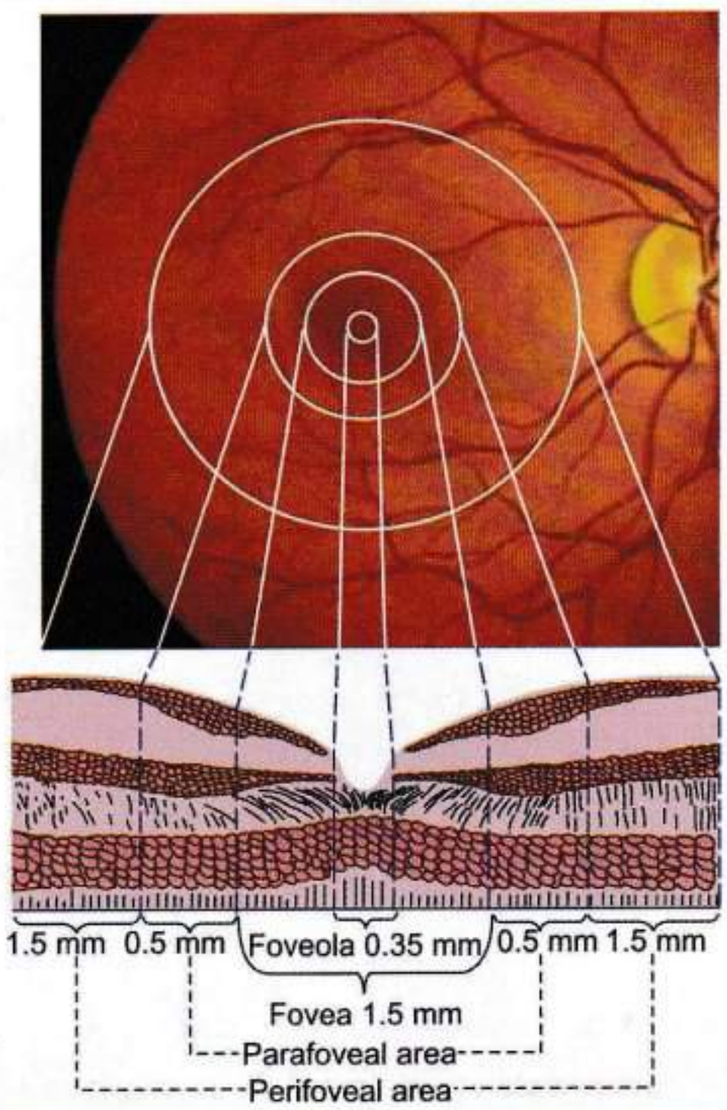


NRR	**Optic cup**
at OD, all retinal layers terminate except nerve fibers, which constitute the rim	central depression, through which central retinal vessels emerge

- OD is known as the *Physiological Blind Spot of Mariotte*[Q]
- Normal optic cup diameter to optic disc diameter **(c/d ratio)** is ≤ 0.3
- **In healthy eyes**, inferior NRR is broadest, followed by superior, nasal and the temporal NRR is thinnest – **ISNT rule**

Macula Lutea

- It is a yellow spot in the posterior part – due to Xanthophyll pigment
- Situated 3 mm[Q]/2DD (disc diameters) **temporal**[Q] to OD and 0.8 mm inferior to it
- Macula contains oxygenated carotenoids, lutein and zeaxanthin which act as antioxidants and also filter blue light
- Diameter: 5.5 mm



- FOVEA – 1.85 mm – 5° visual filled
  Most sensitive part of retina[Q]
  Highest visual acuity[Q] – only cones present
- FOVEOLA – 0.35 mm
  Inner nuclear layer and ganglion cell layer are absent[Q]
- UMBO – responsible for FOVEOLAR light reflex
- FAZ – 0.6 mm – foveal avascular zone situated within fovea
- PARAFOVEAL area – 0.5 mm around fovea
- PERIFOVEAL area – 1.5 mm around fovea – contains maximum concentration of ROD cells
- Macula is called the posterior pole of eye.

Peripheral Retina

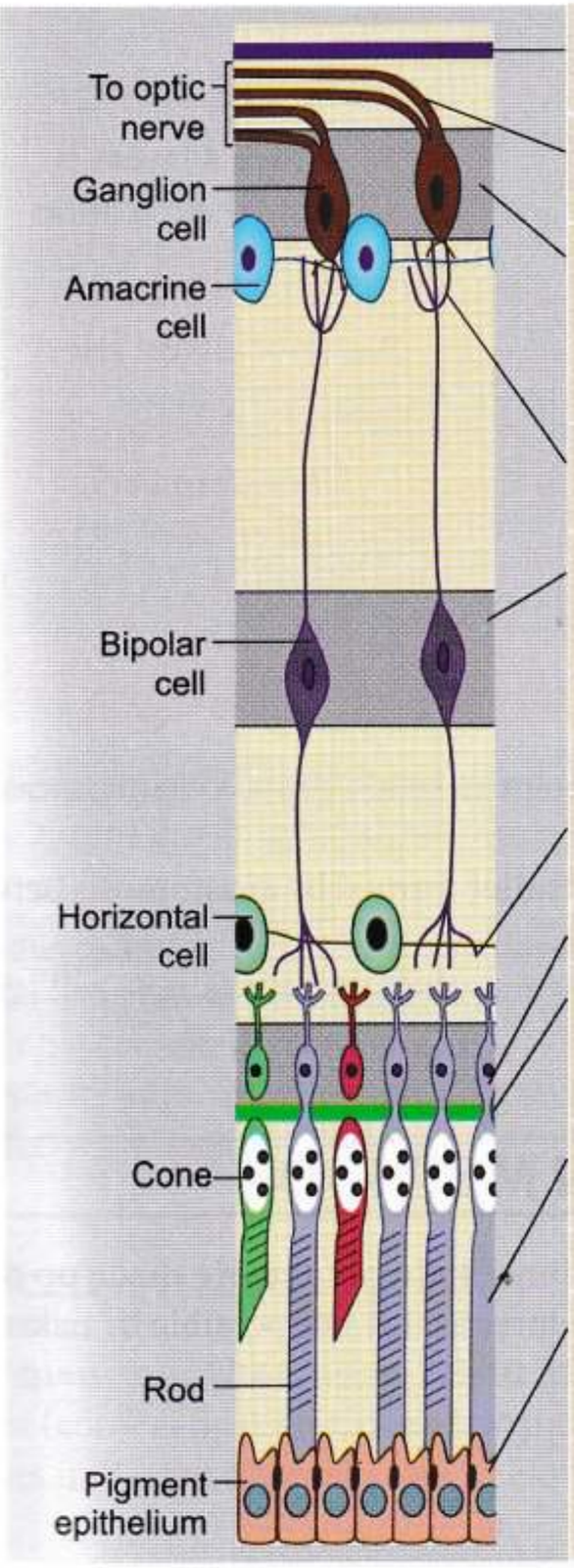
- It is divided into four regions
  - Near periphery
  - Mid periphery
  - Far periphery
  - **Ora serrata** – anterior termination of retina
    - Dentate processes extensions of retina on pars plana
    - Ora bays extensions of pars plana on retina
- Peripheral retina is usually examined by indirect ophthalmoscopy

Layers of Retina

- Retina consists of **ten** layers, divided into 2 broad regions

Neurosensory Retina (NSR)	Retinal Pigment Epithelium (RPE)
contains inner 9 layers, responsible for visual impulse	outermost layer, having metabolic functions

Space between NSR and RPE is known as **Subretinal space**.
(Remember subretinal space is NOT below retina, it is between retina, below NSR)



INTERNAL limiting membrane (10)	PAS positive basement membrane formed by footplates of Müller cells
Nerve fiber layer (9) (NFL)	Unmyelinated axons of ganglion cells which pass through lamina cribrosa – constitute the optic nerve
Ganglion cell layer (8) (GCL)	• Nuclei of **ganglion cells – third order** neurons[Q] • Usually single layered except • Macula – multilayered • Foveola – absent
Inner Plexiform layer (7) (IPL)	Synapses between dendrites of ganglion cells and axons of bipolar cells
Inner nuclear layer (6) (INL)	Contains nuclei of **Bipolar cells – Second order neurons**[Q] Horizontal cells – enhance visual contrast by lateral inhibition. Amacrine cells – help in temporal summation Müller cells – structural support [Q] and metabolism of NSR
Outer Plexiform layer (5) (HENLE's layer)	Synapses between dendrites of bipolar cells and photoreceptors
Outer nuclear layer (4)	Nuclei of rods and cones
External limiting membrane (3)	Formed by junctions between cell membrane of photoreceptors and Müller cells **NOT A TRUE Basement membrane**
Photoreceptors (2)	Outer and inner segments of rods and cones – End Organs of vision–**First order neurons**[Q]
SUBRETINAL SPACE	
Pigment epithelium (1) (RPE)	Constitutes the **outer blood-retinal barrier**[Q] Esterifies retinol Phagocytic function Melanin pigment-helps in absorbing light

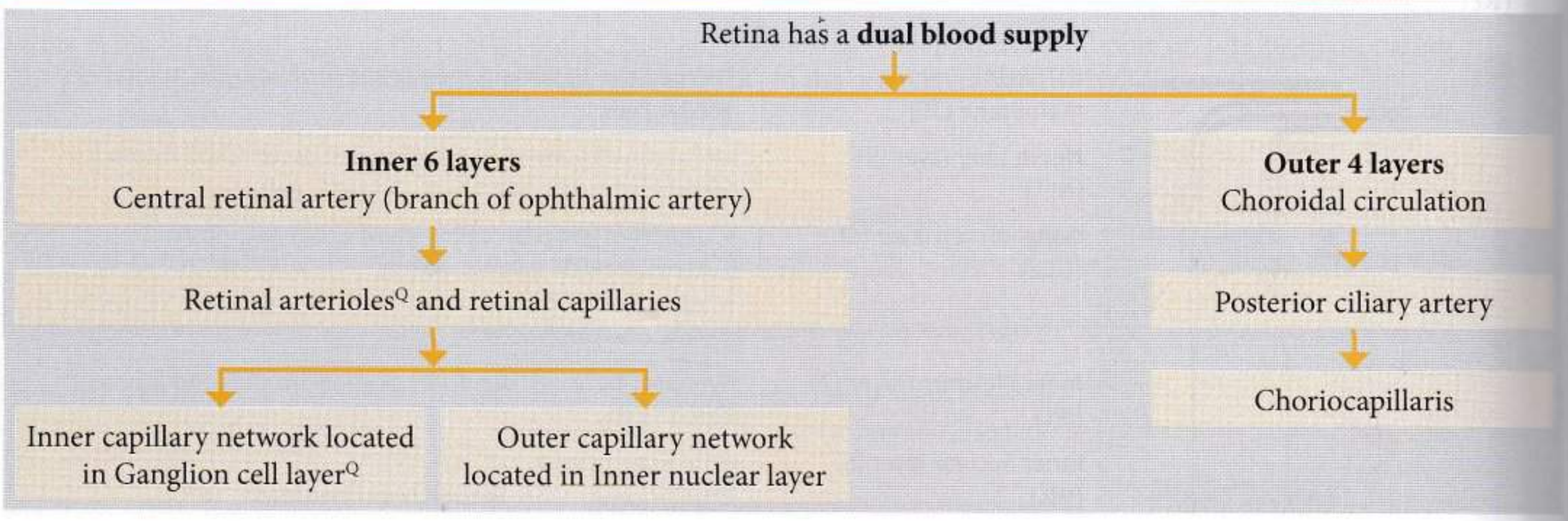
Mnemonic

ING I_2O_2©P_2 = ING $[IO_EP]_2$

High Yield

- Ganglion cells are the **first site of action potential generation**[Q]
- Optic nerve also constitutes the third order neurons[Q], **as it consists of myelinated processes of ganglion cells**
- Retinal detachment occurs between NSR and RPE[Q]
- **Interphotoreceptor matrix (IPM)**[Q] occupies the space between the photoreceptor outer segments and the RPE and functions to provide attachment of RPE to NSR, facilitates phagocytosis and molecular trafficking. It contains[Q]
  - IRBP: Interphotoreceptor retinoid binding protein – functions for efficient transport of retinoids between photoreceptors & RPE.
  - Matrix metalloproteinases
  - SPARC: Sialoprotein associated with rods and cones
  - Proteoglycans and glycosaminoglycans like chondroitin sulfate
  - Hyaluronic acid receptor (CD44)
- Neuroglial cells in retina
  - Muller's cells
  - Astrocytes
  - Microglia
  - Oligodendrocytes (rare)

Blood Supply of Retina


Retina has a dual blood supply
Inner 6 layers
Central retinal artery (branch of ophthalmic artery)
Retinal arterioles
Inner capillary network located in Ganglion cell layer
Outer capillary network located in Inner nuclear layer
Outer 4 layers
Choroidal circulation
Posterior ciliary artery
Choriocapillaris

- **Macula**
  - Receives blood supply from central retinal artery
  - Also sometimes from **Cilioretinal** artery (branch of posterior ciliary artery) – helps to retain central vision in cases of CRAO
- **Optic disc** – Retrolaminar region is usually supplied by the **arterial circle of Zinn or Haller** formed by anastomosis between the retinal and ciliary vessels
- **Inner blood-Retinal barrier**[Q] is formed by **tight** junctions between retinal capillary endothelium cells (single cell layer – which is covered externally by pericytes)

CLINICAL EXAMINATION/INVESTIGATION METHODS

Examination of the posterior segment of eye, i.e. **FUNDUS** (a view of vitreous and the inner lining of the eye made up of the sensory retina, RPE, Bruch's membrane and choroid) requires special instruments/procedures as it is not possible by naked eye torch light examination.
Thus, we discuss some procedures/instruments used.

Ophthalmoscopy

It is a clinical examination of the posterior segment of the eye/fundus. It can be done in 2 ways

Features	Direct ophthalmoscopy (DO)	Indirect ophthalmoscopy (IDO)
Condensing lens	Not Required	Required – Most commonly[Q] **+20D** convex lens is used
Examination distance	As close to patient's eye as possible	At an arm's length
Image	Virtual and Erect[Q]	Real and **Inverted**[Q] (I for I)
Illumination	Not as bright	Bright
Examination through hazy media[Q]	Not possible	Possible
Stereopsis (Binocular depth perception)	Absent	Present – as Binocular investigation
Magnification[Q]	**15** times	3 times with +20D lens **5** times with +14D lens
Accessible fundus view[Q] (based on the fact that magnification is inverse to field of view)	• Posterior to equator • Central fundus • Optic disc and macula • Field of view – smaller – 10°	• Retina visualized anterior to equator also • Peripheral fundus • Ora serrata • Field of view – larger – 45° with +20D lens
Area of field in focus	About 2DD (disc diameters)	About 8DD (disc diameters)
Position of examination	Sitting	Supine (preferable)

Contd...

Features	Direct ophthalmoscopy (DO)	Indirect ophthalmoscopy (IDO)
Scleral indentation	Difficult	Easily done
Instrument	Hand held	Head mounted

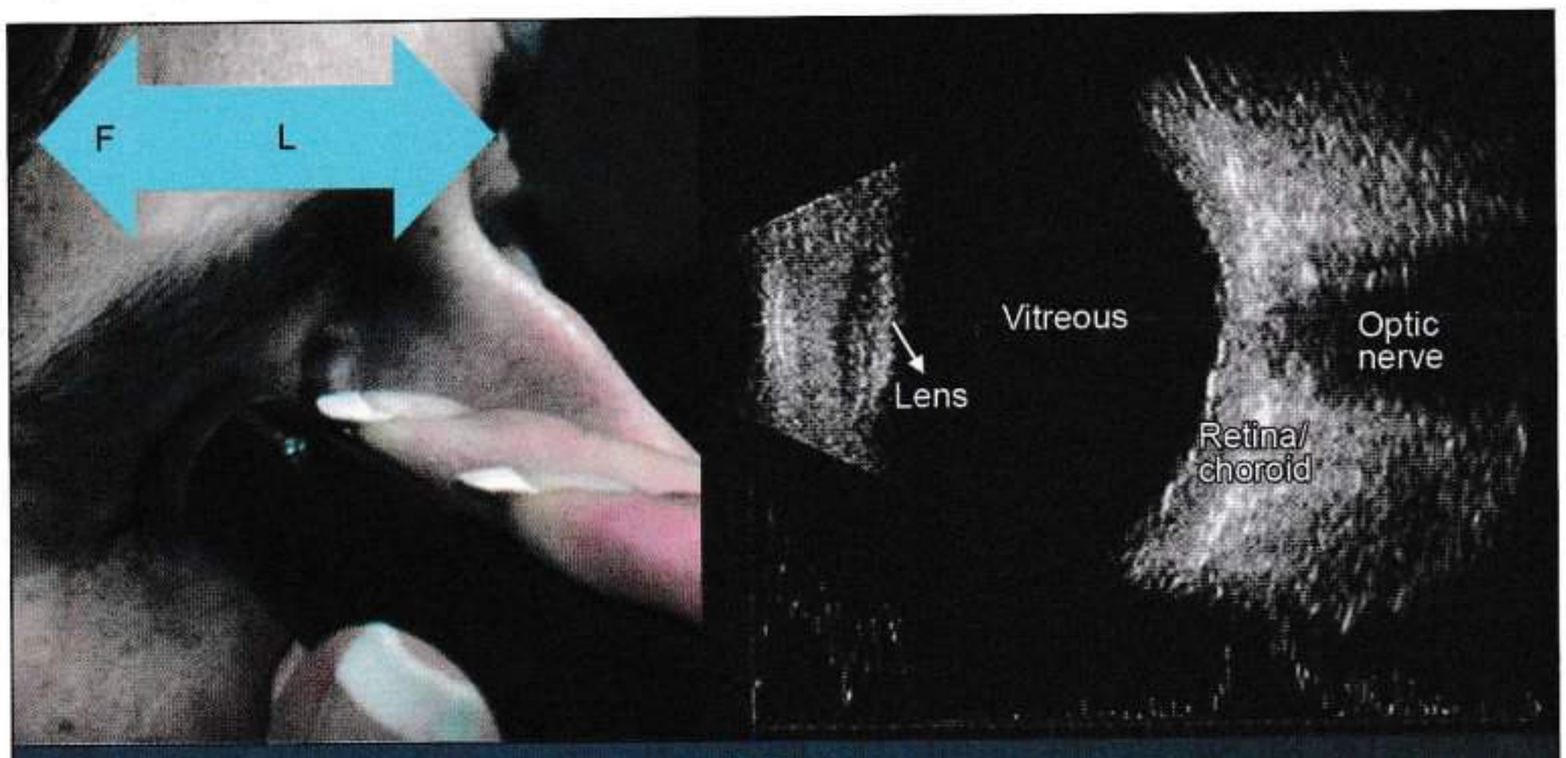
- Indirect ophthalmoscopy is now being done with the use of smartphones also
- Distant direct ophthalmoscopy **(DDO)**^{Q} – done from a distance of **25 cm**^{Q} for examination of anterior segment.

Fundus examination can also be done by

- Slit lamp **biomicroscopy** using +78D or +90D (more commonly) convex lens
- **HRUBY lens** – planoconcave -58.6D lens
- **SLO** – Slit lamp Ophthalmoscopy
- **Goldmann's 3 mirror contact lens** – it has 3 mirrors
  - At 73° – visualize angle of anterior chamber
  - At 67° – visualize retina anterior to equator
  - At 59° – to visualize retina posterior to equator

B-Scan Ultrasonography

Brightness scan USG, using **7.5-10 MHz ultrasound waves** for fundus investigation in patients with opacification of ocular media (corneal opacities, dense cataract) precluding ophthalmoscopy.
Echoes in B-scan are converted to Dots, with brightness intensity being proportional to the echo amplitude.

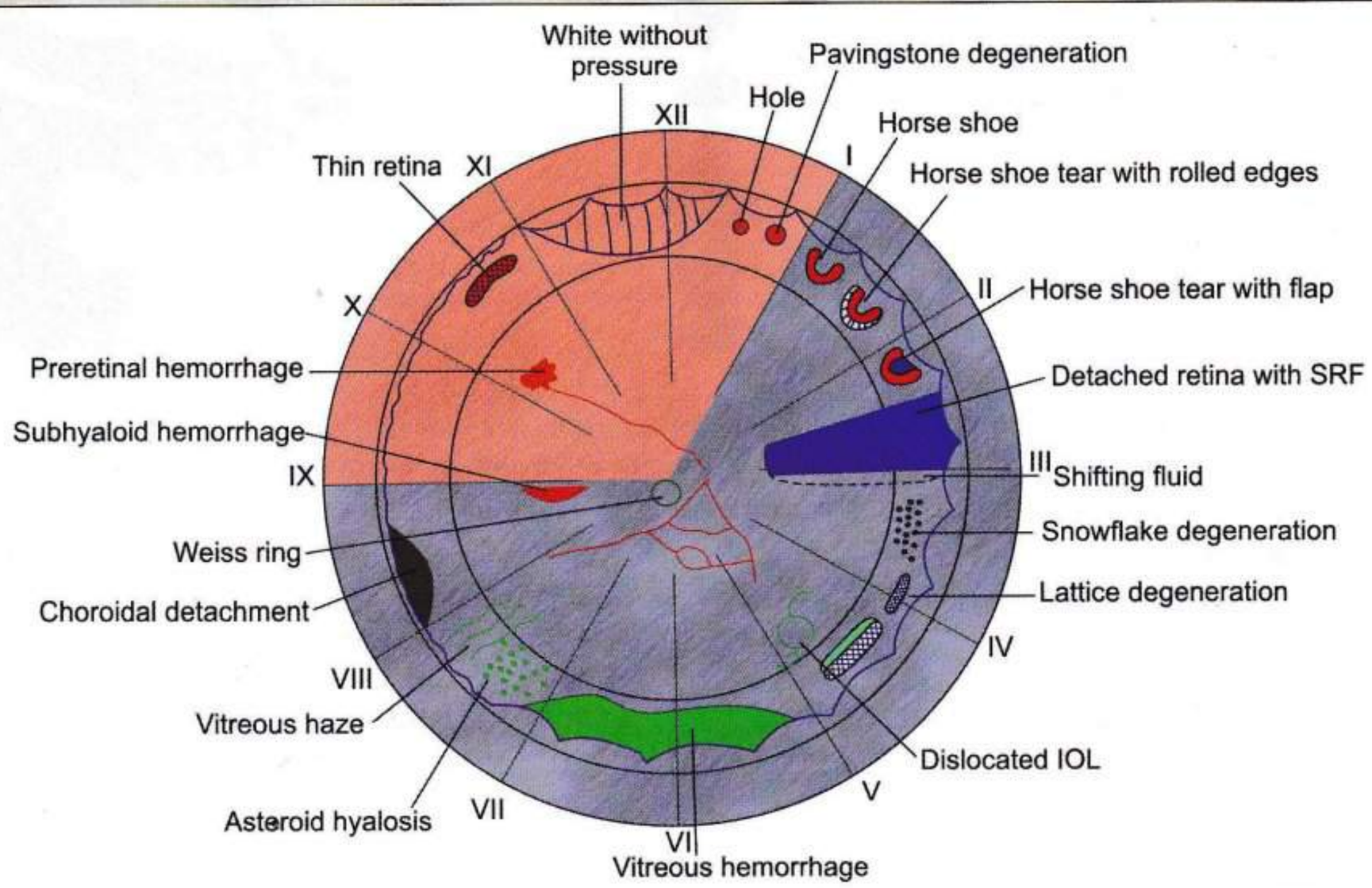


B Scan

Probe placed over the eyelid. High amplitude echoes appear hyperechoic (white-retina & choroid), absent echoes appear as anechoic (black-vitreous)

BONUS PAGE 5

FUNDUS DRAWING



Coding in Red Color

Red – solid

- Retinal arterioles
- Neovascularization
- Vascular abnormalities/anomaly
- **Attached retina**[Q]
- Hemorrhages (pre-retinal and intra-retinal)
- Open interior of conventional retinal breaks
  - Retinal hole
  - Horse shoe shaped tear (red) with rolled edges (blue)
- Normal macula is drawn as a red dot

Red-Cross-lined

- Inner portion of CRA
- Thin areas of retina

Coding in Blue Color

Blue – Solid

- **Detached retina**[Q]
- Retinal veins
- Outlines of ora serrata
- VR traction tufts
- Intra-retinal cysts [with overlying curvilinear stripes to show configuration]

Blue-cross-lined

- Inner layer of retinoschisis
- White with or without pressure
- Detached pars plana epithelium anterior to separation of ora serrata
- Rolled edges of retinal tears [curved lines]

Stippled/Circled

- Cystoid degeneration

Interrupted Lines

- Outline of change in area or folds of detached retina because of shifting fluid

Coding in Green Color

Green – solid

- Opacities in the media
- **Vitreous hemorrhage**
- Vitreous membrane
- **Intraocular foreign body (IOFB)**
- Retinal operculum
- Cotton wool spots

Green Stippled/Dotted

- Asteroid hyalosis
- Frosting or snowflakes on cystoid degenerations, retinoschisis, or lattice degeneration

Coding in Brown Color

Brown – solid

- Uveal tissue
- Pigment Epithelial Detachment
- Outline of posterior staphyloma
- Malignant **choroidal melanomas**
- Choroidal detachment

Coding in Yellow Color

Yellow – solid

- Intraretinal edema
- Intraretinal or subretinal **exudate**
- Deposits in the RPE

Yellow – stippled

Drusen

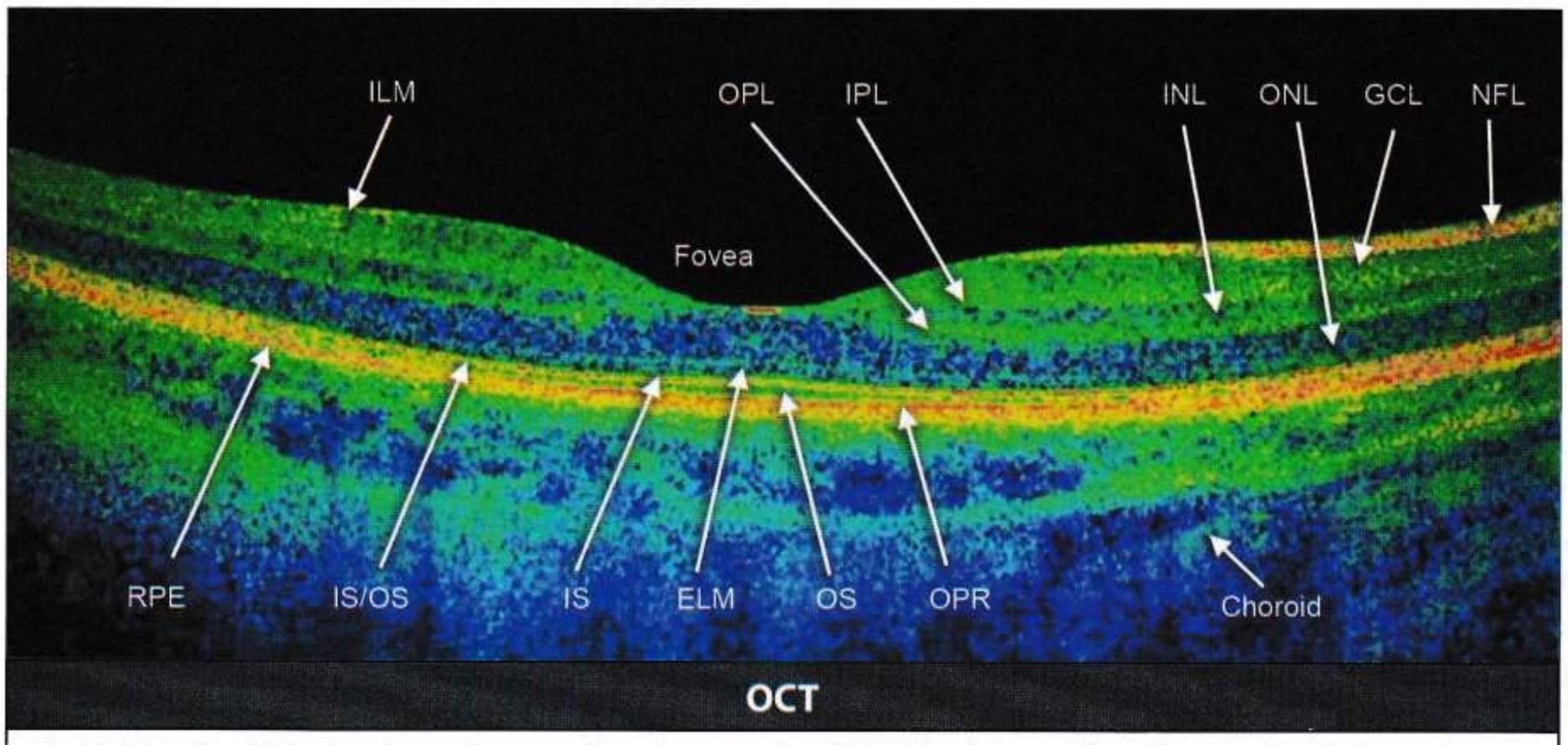
Coding in Black Color

Black – solid

- Edge of buckle beneath attached retina
- Naevi
- Pigment
- Pigmented demarcation lines

Optical Coherence Tomography (OCT)

- OCT is similar to USG except that it uses infrared light instead of sound waves.
- **Principle** – based on low coherence interferometry
- Time domain OCT has a resolution of 10 microns (uses wavelength of 1310 nm) whereas Fourier domain OCT achieves resolution of 3–6 microns (uses wavelength of 840 nm)
- Views from OCT are known as "optical biopsies" and are used to evaluate lesions of retina (Macular lesions especially), optic nerve and vitreous.



Red; high reflectivity structures, Green-yellow: intermediate, Blue-black: low reflectivity. Detailed information on retinal thickness also displayed. Note that fovea appears as a depression

Fundus Fluorescein Angiography

Fundus fluorescein angiography (FFA) allows the study of circulation of retinal and choroid by measuring the fluorescence of Sodium fluorescein dye.

Method

Intravenous injection of Sodium fluorescein

5 mL of 10% solution – injected into the Antecubital vein. It is an **orange colored** water soluble dye

↓

Enters ocular circulation via ophthalmic artery, 8–12 seconds after injection – only 20% is unbound entering the circulation, 80% gets bound to albumin

↓

White light is passed through a Blue filter, such that only blue light (465–490 nm) enters – leading to excitation of fluorescein molecules – with fluorescence occurring at 520-530 nm.

↓

Images are taken at

9–15 seconds : **Choroidal filling phase**, followed by arterial phase (filling of retinal arterioles) 1 second later
15–25 seconds : **Arteriovenous phase** – filling of arteries and capillaries with laminar flow in veins
30–60 seconds : **Venous phase** – complete filling of veins
1–10 minutes : Late **recirculation phase**

Fluorescein is absent from retinal vasculature after 10 minutes

Side Effects

- Temporary yellowing of skin and conjunctiva
- Orange – yellow **discoloration of urine**[Q] – lasts 24 to 36 hours
- Vasovagal reactions
- Extravasation in skin – pain

FFA should not be done in patients with renal compromise[Q]

EXTRA MILE

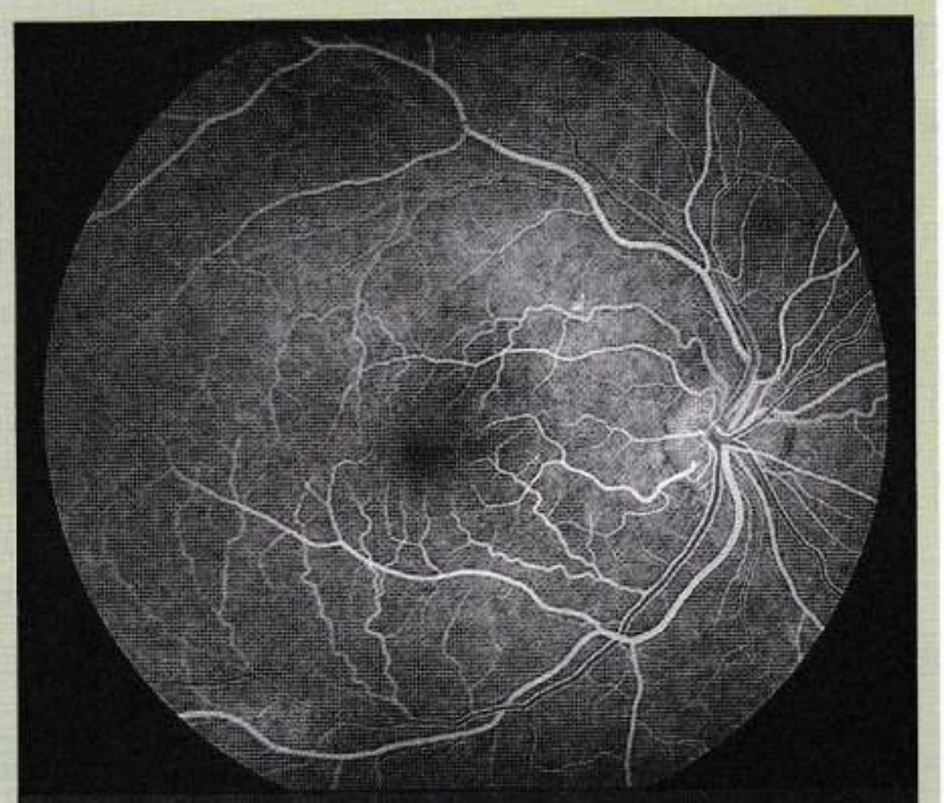
Abnormalities seen on FFA

Autofluorescence	Hyperfluorescence	Hypofluorescence
Naturally occurring fluorescence due to • Optic disc drusen • Lipofuscin in retinal drusen • Astrocytic hamartoma	• **Leakage** – due to dysfunction of vascular endothelial tight junctions e.g. DR, CME, CRVO • **Staining** – due to prolonged retention in tissues e.g. Drusen, optic nerve tissue • **Pooling** – due to break down of RPE tight junctions e.g. CSR, PED in ARMD • **'Window' defect** – a view of normal choroidal fluorescence through a defect/loss of RPE	• **Vascular filling defects** – due to nonperfusion e.g. CRAO, CRVO • **Masking** – blockage due to a pre-retinal lesion e.g. Exudates, Cotton wool spots, choroidal nevi

EXTRA MILE

- **Fovea appears as a Central DARK SPOT on FFA due to**
  - Absence of blood vessels in FAZ
  - Xanthophyll blocking choroidal fluorescence
  - RPE blocking choroidal fluorescence due to excess melanin content at macula

Thus, FFA can be used to assess macular pathologies.



FFA – Early venous phase

Note the laminar filling of veins

Indocyanine Green Angiography

Compared to FFA

ICGA is better for imaging choroidal circulation as

- ICG is water soluble, **98% protein bound**[Q] after intravenous injection – thus, **better retention**[Q] and low permeability
- ICGA fluoresces in near-infrared light (805 nm)[Q] – thus, **better penetration** of ocular pigments such as melanin, xanthophyll as well as exudates

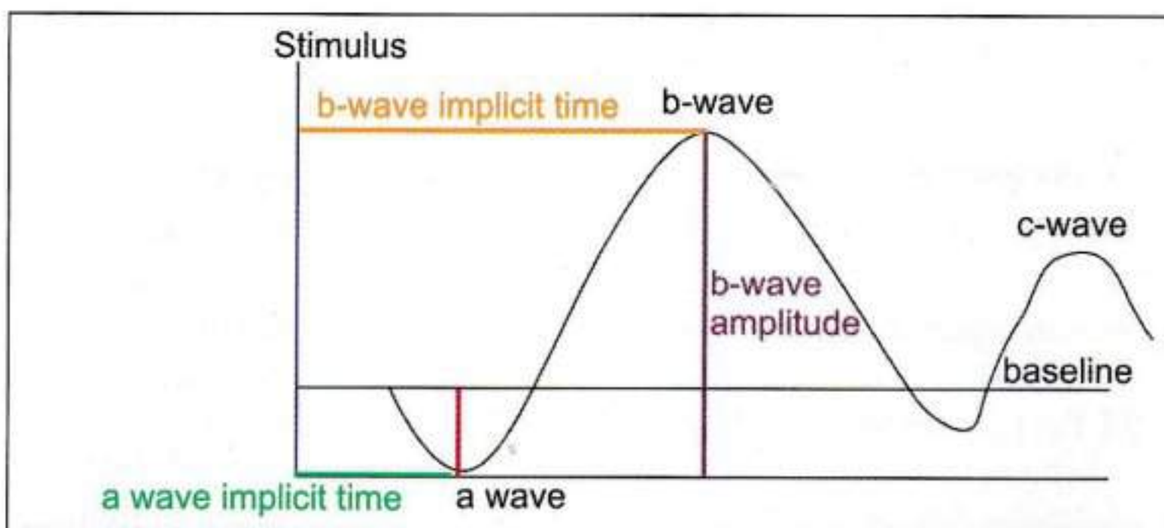
Side Effects

- ICG contains **5% Iodide** – contraindicated in allergic patients
- Nausea, vomiting and urticaria
- Contraindicated in liver disease
- Contraindicated in patient taking Metformin

Useful in choroidal pathologies like ARMD (occult CNVM, RPE detachment), PCV, CSR, choroidal tumors, myopia for lacquer cracks, etc.

Electroretinography (ERG)

- ERG is the record of an '**action potential**' produced by retina upon stimulation by light or modification of the normal corneoretinal potential of 1mV in response to a flash of light.
- ERG measures a **panretinal** response and does not correlate with visual acuity



'a' wave – generated by photoreceptors
'b' wave – generated by Müller cells and Bipolar cells
'c' wave – generated by RPE (related to retinal metabolism)

Electroretinogram – duration is <150 msec. Recording is made between a corneal contact lens electrode and a reference electrode on the forehead

Types of ERG

- Full field ERG – consists of 5 recordings
  - Rod response
  - Combined rod and cone response
  - Oscillatory potentials

  ] **Scotopic ERG** elicited after 30 minutes of dark adaptation

  - Single flash cone response
  - 30 Hz flicker response

  ] **Photopic ERG** elicited after 10 minutes of bright illumination
- **Early receptor potential (ERP)** – generated by cones during conversion of visual pigments
- **Multifocal ERG** – tests **cone**[Q] generated response – used for determination of macular dysfunction
- **Pattern ERG** – correlates with the integrity of the optic nerve and thus information about the ganglion cells. It is used to diagnose early glaucomatous changes
- **Bright-flash ERG** – if unrecordable, indicates poor prognosis after retinal trauma

EXTRA MILE

Abnormalities of ERG

- Inversion of b wave: a wave amplitude ratio
- Delay in 30 Hz cone flicker response

] Central retinal vein occlusion (CRVO)

- **Non recordable ERG**
  - Retinitis pigmentosa – (diffuse retinal dystrophy)
  - Total retinal detachment
  - Leber congenital amaurosis
- Negative ERG
  - X linked retinoschisis
  - Congenital stationary might blindness
  - Enhanced S cone syndrome
- Non recordable photopic ERG
  - Cone dystrophies
  - Achromatopsia

Electro-Oculography (EOG)

- EOG is a measure of '**standing potential**' – generated due to changes in voltage across the apical and basal membranes of RPE
- It reflects the **activity of RPE and photoreceptors**, thus any pathology of inner retina will have a normal EOG
- Arden ratio = $\frac{\text{Maximum potential in light}}{\text{Minimum potential in dark}} = \frac{\text{Light peak}}{\text{Dark trough}}$ Normally, **>1.85 or 185%**[Q]

VASCULAR RETINAL DISORDERS

Disorders which primarily affect the vessels in the retina, leading to HYPOXIA by various mechanisms such as capillary leakage or capillary occlusion, depending on the causative pathology

DIABETIC RETINOPATHY

Diabetic retinopathy (DR) is the leading cause of blindness in patients between 25 and 74 years of age in the developed countries.

Risk Factors

- **Duration** of diabetes is directly proportional to risk for DR[Q]
- Poor diabetic control with increased levels of **HbA1C**
- **Pregnancy** associated with acceleration of DR changes
- Hypertension, stroke and cardiovascular disease
- Diabetic nephropathy – serum creatinine[Q] levels correlate with the risk of DR
- Smoking and alcohol consumption have not been found to be related

Pathogenesis

Correlate Box

DR is a microangiopathy in which chronic hyperglycemia leads to biochemical and physiologic changes, leading to anatomical **endothelial lesions**

Biochemical mechanisms of cellular damage
- Intracellular sorbitol accumulation
- Protein kinase C-activation[Q]
- Maillard reaction leading to formation of (AGE) advanced glycation end products
- Accumulation of reactive oxygen[Q] intermediates

↓

Anatomic lesions – Capillaropathy
Loss of Pericytes – **earliest histologic change/sign of DR**[Q] - causes impairment of inner blood-retinal barrier
and
Capillary basement membrane thickening

↓

Leakage and occlusion of capillaries

↓

HYPOXIA[Q]

↓

Relative retinal ischemia – angiogenic stimulator

↓

- Release of **VEGF-A**[Q] (Vascular endothelial growth factor)
- **SNP** (single nucleotide polymorphisms) mediated Erythropoietin expression
- PKC - mediated expression of SHP-1, causing **resistance to PDGF**

↓

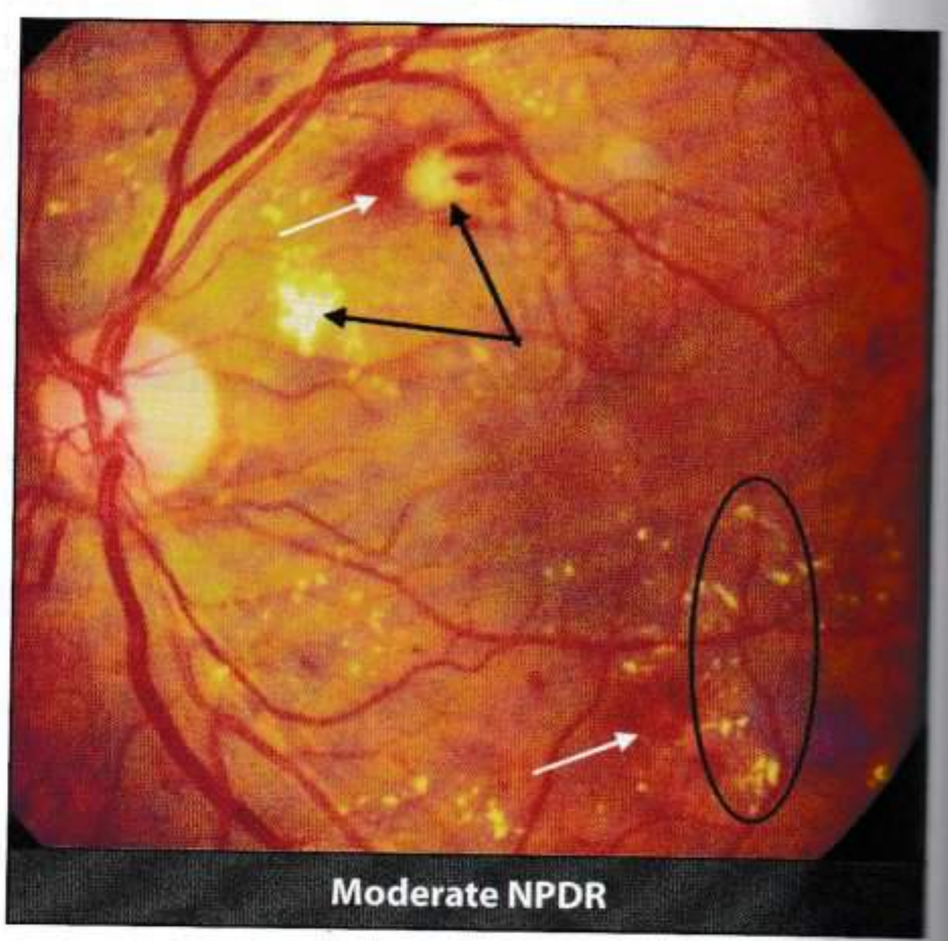
NEOVASCULARIZATION of retina – Hallmark of DR[Q]

Classification and Clinical Features

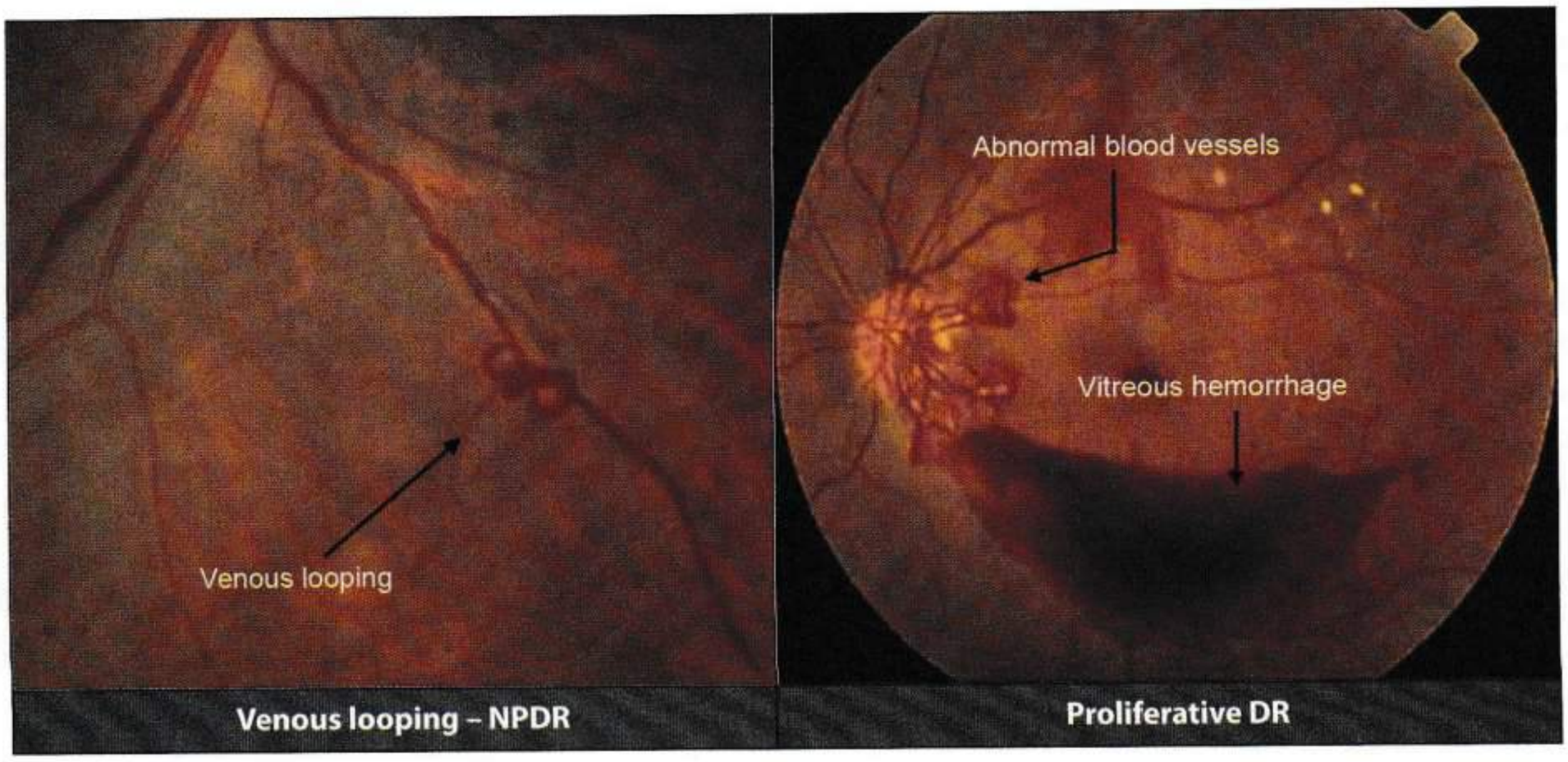
Abbreviated Early Treatment Diabetic Retinopathy Study (ETDRS) Classification

Category/Description	Management
Non-proliferative diabetic retinopathy (NPDR) – presents without proliferation of new vessels	
Mild • Any or all of – microaneurysms, retinal hemorrhages, exudates, cotton wool spots • No IRMA or significant beading	Medical control of diabetes with follow up in 9–12 months
Moderate • Severe retinal hemorrhages (about 20 medium-large per quadrant) in 1-3 quadrants or mild IRMA • Significant venous beading in 1 quadrant • Cotton wool spots	Medical control of diabetes with follow up in 6 months
Severe **4-2-1 rule, one of** • Severe hemorrhages in all 4 quadrants • Significant venous beading in ≥2 quadrants • Moderate IRMA in ≥1 quadrant	Medical control of diabetes with follow up in 4 months High risk PDR in **15%** within a year
Very severe Two or more of the 4-2-1 rule	Medical control of diabetes with follow up in 2-3 months High risk PDR in **45%** within a year[Q]
Proliferative diabetic retinopathy (PDR) – presents with proliferation of new vessels	
Mild-Moderate Neovascularization of the Disc (NVD) or Neovascularization Elsewhere (NVE)	Prompt Pan-retinal photocoagulation (PRP) is done if type2 diabetes mellitus in a patient >40 years of age, otherwise defer PRP
High risk PDR[Q] • NVD ≥1/3 disc area • NVD with vitreous or pre-retinal hemorrhage • NVE >1/2 disc area with vitreous or pre-retinal hemorrhage	**Treatment advised** Prompt Pan-retinal photocoagulation

- **Microaneurysms**
  - Localized out pouchings formed where pericytes are absent
  - Develop in Inner nuclear layer (**INL**)[Q]
  - **Earliest sign of DR**[Q] – visible as tiny red dots
  - On FFA – hyperfluorescent due to leakage
- **Retinal hemorrhages** ***(white arrow)***
  - **Flame shaped**[Q] – arise from pre-capillary arterioles in the Nerve fiber layer (NFL), superficial[Q]
  - **Dot and Blot**[Q] – arise from venous end of capillaries in the Outer plexiform layer (OPL), deep[Q]
- **Exudates**[Q] ***(black oval)***
  - Lipid and lipoprotein deposits in the Outer plexiform layer (OPL)
  - Develop around leaking microaneurysms/ chronic localized edema – visible as waxy yellow lesions
  - On FFA – hypofluorescent due to blockage
- **Cotton wool spots**[Q] ***(black arrow)***
  - Collections of neuronal debris (histologically cytoid bodies) in the Nerve fiber layer (NFL)
  - On FFA – hypofluorescent due to blockage
- **Venous changes** – looping (*black arrow)*, beading, dilation and tortuosity due to severe ischemia
- **IRMA** (Intraretinal microvascular abnormalities) – arteriovenous shunts bypassing the capillary bed



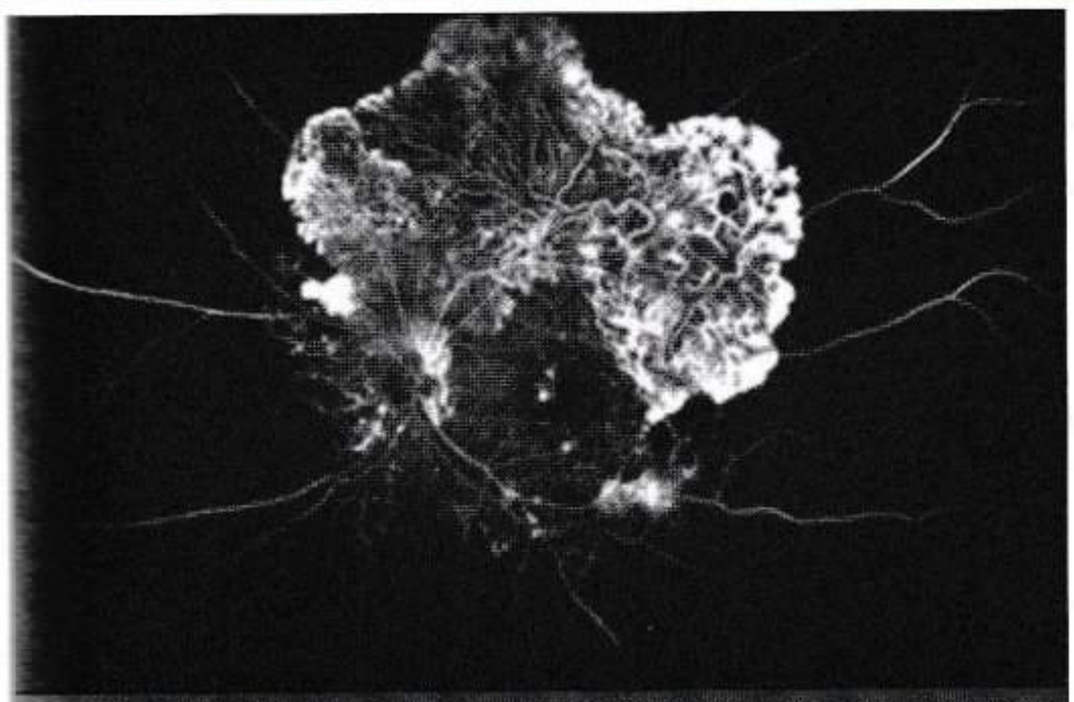
Moderate NPDR



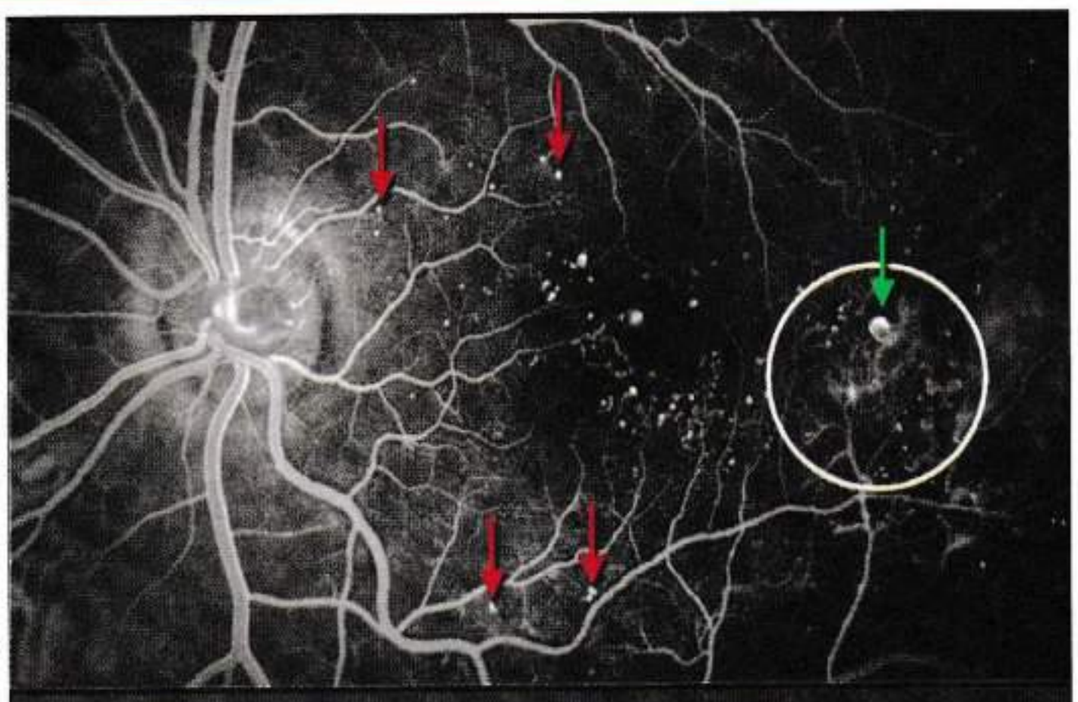
Venous looping – NPDR | Proliferative DR

- NVD – Neovascularization on or within 1 disc diameter of the optic disc
- NVE – Neovascularization away from the disc

FFA Findings



Neovascularization – seen at/within 1DD of the disc (NVD) and elsewhere (NVE) (New vessels proliferate in response to hypoxia as a tuft of abnormal leaky vessels)



Microaneurysms – scattered hyperfluorescent spots (red arrows), Neovascularization (green arrow) with macular edema – due to leakage

Treatment

NPDR

- As noted above, the only advocated treatment is control of Diabetes and associated risk factors (Hypertension) proven in various studies (UKPDS for Type 2 DM and DCCT for Type 1 DM)

PDR

- **Treatment of choice** – Pan-retinal photocoagulation (PRP)[Q]
  It works by decreasing the O_2 demand and thereby reducing hypoxia and VEGF release

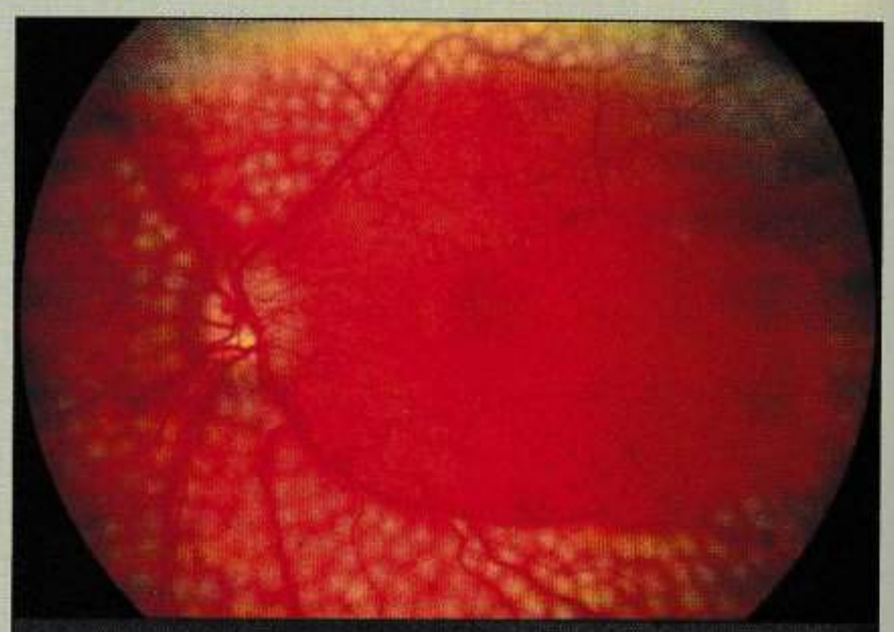
EXTRA MILE

- ETDRS recommended use of **Aspirin** (650 mg/day) to reduce the risk of cardiovascular diseases in diabetics, but, aspirin use **does not** affect progression of DR and **doesnot** affect visual acuity
- **Fenofibrate** – (PPAR) peroxisome proliferator activated receptor alpha agonist – has been proven beneficial to reduce the progression rate in NPDR and the need for further treatment by two studies (FIELD study & ACCORD study)

Extra Mile

Laser used	Argon laser - 510 nm wavelength (conventional) Frequency doubled Nd: YAG solid state laser (PASCAL – automated pattern scanning laser delivery system)
Spot size on retina[Q]	200 µm[Q] to 500 µm
Duration of burn	0.05 – 0.1 seconds, with burn edges 1 burn width apart
No. of burns	1200 to 1600, placed 2-3DD from the center of macula extending peripherally

- Topical anesthesia is adequate in patients
- PRP is usually done in **multiple sittings**, as PRP **may cause visual field defects**
- PRP does not abolish the fibrous component, if seen associated with neovascularization

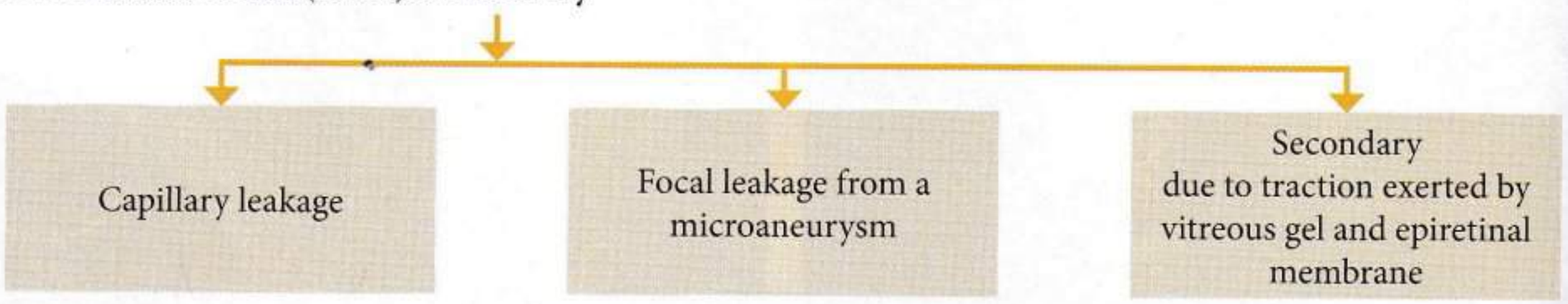


PRP burns

- Anti VEGF drugs (Ranibizumab, Bevacizumab & Aflibercept)
- Pharmaceutical vitreolysis with hyaluronidase and/or microplasmin to induce complete posterior vitreous detachment (PVD), leading to removal of vitreoretinal adhesions and improving O_2 supply to retina

Diabetic Maculopathy

- Diabetic macular edema (DME) is **caused by**


Capillary leakage
Focal leakage from a microaneurysm
Secondary due to traction exerted by vitreous gel and epiretinal membrane

- It is **best diagnosed on** Slit Lamp biomicroscopy using +78D or +90D lens along with FFA (showing leakage) and OCT (showing retinal thickening)
- **CSME (Clinically Significant Macular Edema)**
  - Retinal thickening within 500 µm of center of macula
  - Exudates within 500 µm of center of macula (if retinal thickening present anywhere)
  - Retinal thickening ≥1500 µm (1DD) any part of which is within 1DD of center of macula

Treatment

- **Treatment of Choice:** Focal/Grid Argon Laser Photocoagulation[Q]

Contraindicated in Ischemic Maculopathy, if FAZ > 1000µm or 1nm (normal FAZ 0.4–0.6mm)

Spot size – 50 to 100 µm[Q] with an exposure time of 0.1 seconds

- **Intravitreal Triamcinolone** – useful in ischemic maculopathy, DME in a pseudophakic patient and a patient who has coexistent cardiovascular disease
- **Pars Plana vitrectomy** when DME associated with vitreal traction

- **Centre involving CSME**, said to occur if
  - Edema within 300 μm from center of macula
  - Foveal thickness > 250 μm
  - Visual acuity < 6/12

Anti VEGF drugs[Q] – Intravitreal[Q]
Ranibizumab (Lucentis) 0.05 mg/0.5 mL monthly for 3 months

If foveal thickness <250 μm and VA ≥ 6/9 → Defer focal laser photocoagulation (done after 24 months)

If no improvement → Consider adding Intravitreal steroids and continue anti-VEGF therapy

Complications/Advanced Diabetic Eye Disease

- **Vitreous (intragel) hemorrhage**[Q], Pre-retinal (retro hyaloid) hemorrhage – **due to** bleeding from abnormal vessels – **neovascularization of retina**[Q] **in PDR**
- Tractional retinal detachment
- **Rubeosis Iridis** (Neovascularization of iris/NVI) – occurs due to anterior segment hypoxia caused by severe retinal ischemic demand on anterior segment. Requires prompt PRP, in absence/presence of PDR.

Extra Mile

Indications for Pars Plana Vitrectomy[Q] (PPV) in Diabetes

- Dense, non-clearing vitreous hemorrhage[Q]
- Progressive, tractional RD with macular involvement[Q]
- Combined, tractional and rhegmatogenous RD
- Diffuse DME with posterior hyaloid traction and extensive fibrovascular epiretinal membrane[Q]

If Traction, treatment shall be PPV

High Yield

- **Screening for Diabetic retinopathy**
  - 5 years after onset in Type 1 Diabetes[Q]
  - At the time of diagnosis in Type 2 Diabetes[Q]
- **Most common**[Q]
  - Cause of loss of vision in DR/NPDR – Diabetic macular edema[Q]
  - Cause of loss of vision in PDR – Vitreous hemorrhage[Q]
  - Cause of blindness in DR – Retinal detachment[Q]
- Order of treatment
  DME → PDR → Cataract surgery
- Lipaemia retinalis – milky fluid filled retinal vessels due to >2000 mg/100 mL triglyceride concentration

HYPERTENSIVE RETINOPATHY

Retinopathy is the most common manifestation of hypertension which develops due to acute/chronic rise in blood pressure. Retinopathy along with left ventricular hypertrophy leads to increased chances of other organ damage.

Pathology

Correlate Box

Hypertensive retinopathy affects precapillary arterioles and capillaries

Vasoconstrictive phase – initial response – vasospasm

↓

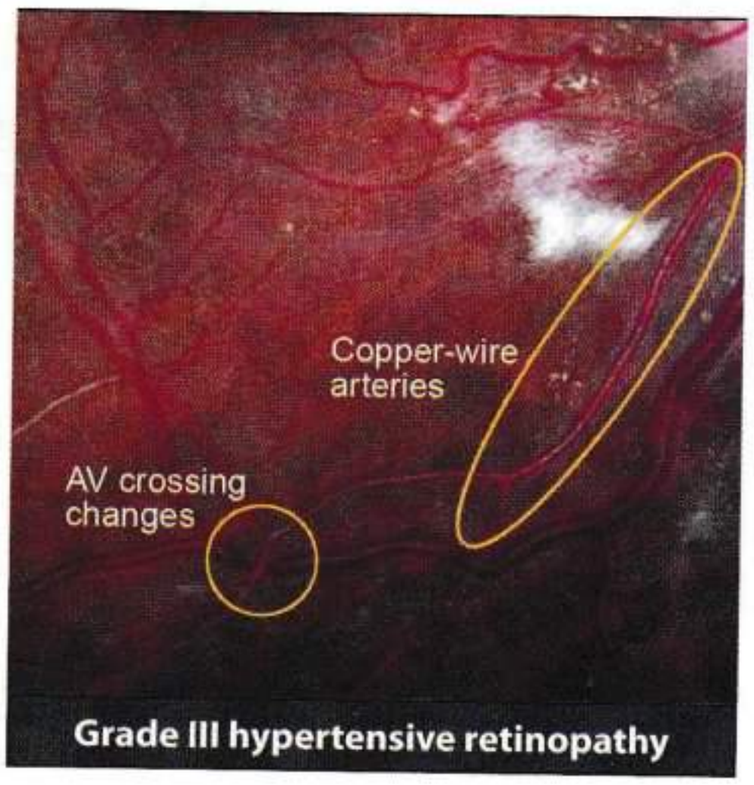
Sclerotic phase – arteriovenous changes due to compression of veins by structural changes (atherosclerosis and rigidity of vessel wall) in the arterioles

↓

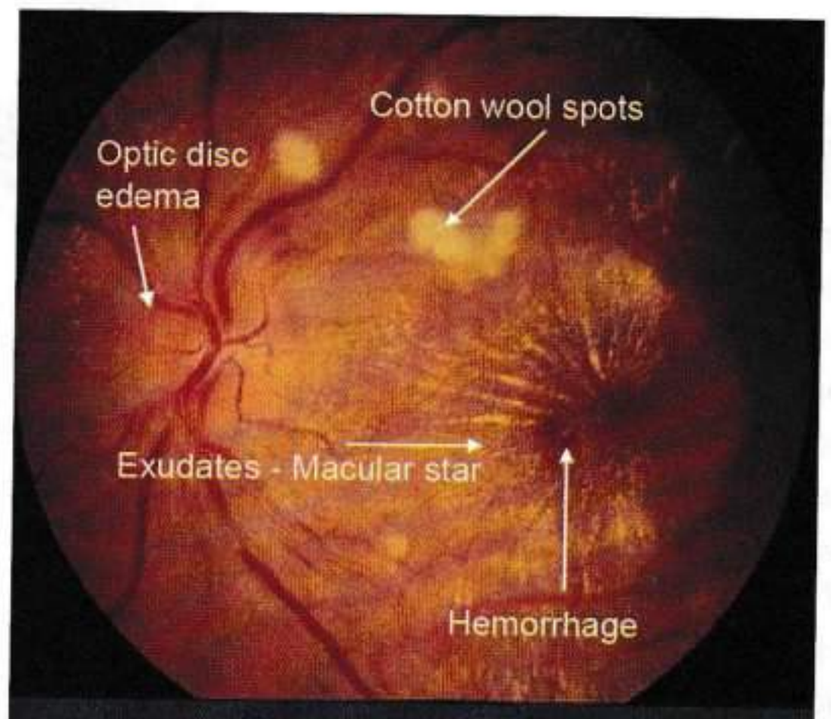
Exudative phase – inner blood-retinal barrier is disrupted due to hypoxia, leading to hemorrhages and other manifestations

Classification and Clinical Features

	KEITH-WAGNER-BARKER	SCHEIE
Grade I	Narrowing of retinal arterioles – arteriolar attenuation [Normal AV diameter ratio 2:3, in Hypertensive retinopathy -1:3]Q	Broadening/widening of the light reflex
Grade II	Salus sign – deflection of veins at AV crossing	—
Grade III	**B**onnet sign – **b**anking of veins at AV crossing Gunn signQ – tapering of veins at AV crossing Cotton wool spotsQ and flame shaped hemorrhagesQ are also seen	Copper wiring of arterioles — exaggerated light reflex
Grade IV	Grade III changes (+) PapilledemaQ	Silver wiring of arterioles highly exaggerated light reflex
	Malignant Hypertension – presents with retinal edemaQ, cotton-wool spots, hard exudates in a **macular star**Q configuration	



Grade III hypertensive retinopathy



Malignant Hypertension
Grade IV hypertensive retinopathy

Mnemonic

Salman Khan – nickname is **Salu**	→	**Salus** sign
Kept his **Gun**	→	**Gunn's** sign
On the **Bonnet** of his car	→	**Bonnet's** sign

Choroidopathy

- May be seen **in accelerated hypertension/malignant hypertension** in young adults
- Elschnig spots – due to focal choroidal infarcts
- Siegrist streaks – due to fibrinoid necrosis
- Exudative retinal detachment

CENTRAL RETINAL VEIN OCCLUSION (CRVO)

Pathology

Venous occlusion due to systemic/local factors causes
Stasis of blood flow (Non-ischemic stage)
(occlusion usually occurs at posterior to lamina cribrosa due to impingement by central retinal artery)

↓

Hypoxia of the involved retina

↓

Damage to capillary endothelial cells and leakage (**Ischemic stage**)

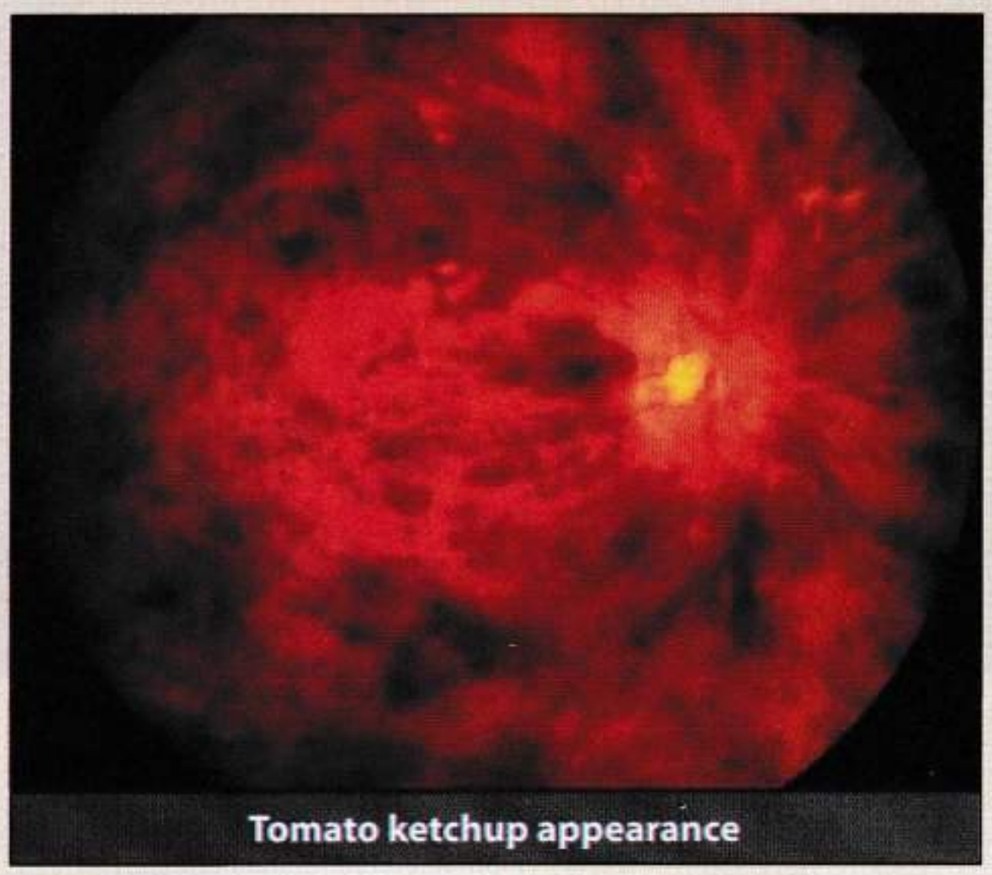
Clinical Features

Risk Factors

- Systemic vascular diseases – **Hypertension (most common cause)**, carotid insufficiency, hyperlipidemia, diabetes mellitus
- Ocular disease – POAG[Q], ischemic optic neuropathy
- Hematologic diseases – blood dyscrasias, hypercoagulable disorders (Protein C, S deficiency, Factor V Leiden mutation)
- Medications: Oral contraceptive pills, diuretics
- Infections vasculitis: Sarcoidosis, HIV, HZV, syphilis
- Age > 65 years

Types

Non-Ischemic CRVO	Ischemic CRVO
75% cases, most common type	Less common
Sudden, Painless loss of vision[Q]	Sudden and severe, painless visual loss
RAPD – mild or absent	Marked
Mild hemorrhages in the periphery	Severe hemorrhages involving periphery and posterior pole – giving **Tomato splash**[Q]/**Tomato ketchup**[Q]/Blood and thunder appearance[Q]

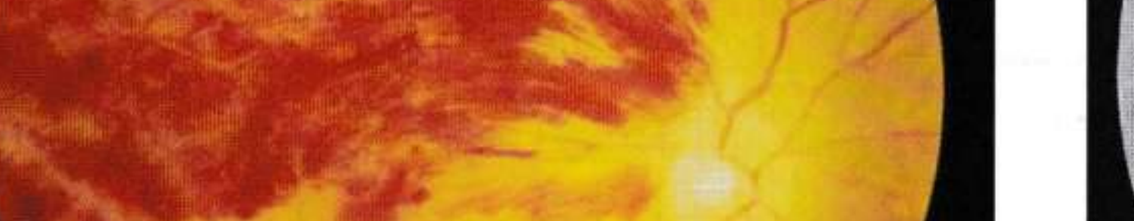


Tomato ketchup appearance

Non-Ischemic CRVO	Ischemic CRVO
Cotton wool spots and tortuosity of vessels	Extensive cotton wool spots and tortuosity of vessels
Macular edema[Q] commonly occurs	Macular ischemia occurs
Does not occur	Rubeosis iridis[Q] (**NVI**) occurs causing neovascular glaucoma known as **100 DAY GLAUCOMA**[Q] NVD/NVE rarely occurs in CRVO
FFA < 10 disc area of non-perfusion	FFA > 10 disc area of non-perfusion
ERG – Normal	ERG – amplitude of b wave < 60%
Prognosis – Good, related to initial visual acuity. Main cause of visual loss is macular edema[Q]	**Prognosis – Poor** due to macular ischemia
Treatment – Macular edema • **Laser photocoagulation not done** • Intravitreal Triamcinolone 2 injections (1 mg) – SCORE study • 0.7 mg dexamethasone intravitreal implant – GENEVA trial • Intravitreal AntiVEGF drugs – Ranibizumab, Aflibercept	**Treatment** • PRP/Scatter photocoagulation done only on appearance of NVI/ NVA • Prophylactic PRP not done

Branch Retinal Vein Occlusion (BRVO)

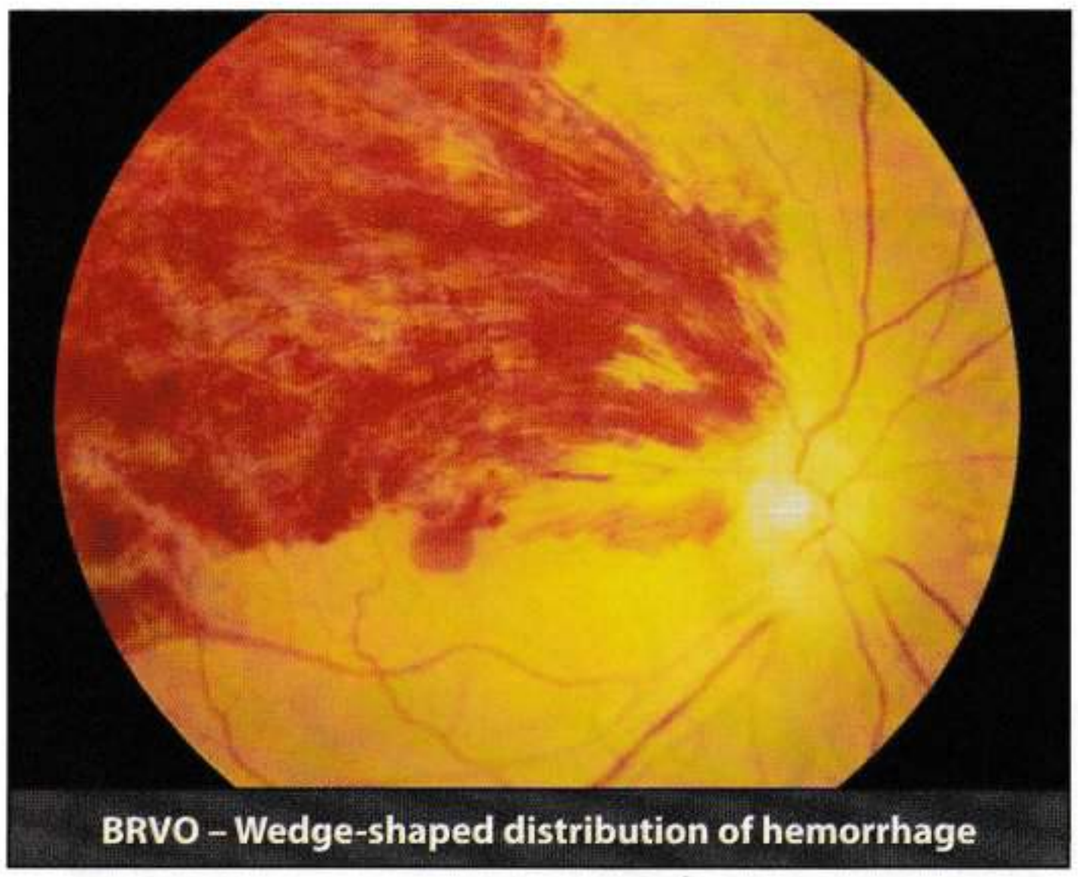
- **Most common site** – arteriovenous crossings
- **Most common sector** – Superotemporal[Q]
- Presents like CRVO, with intraretinal hemorrhages



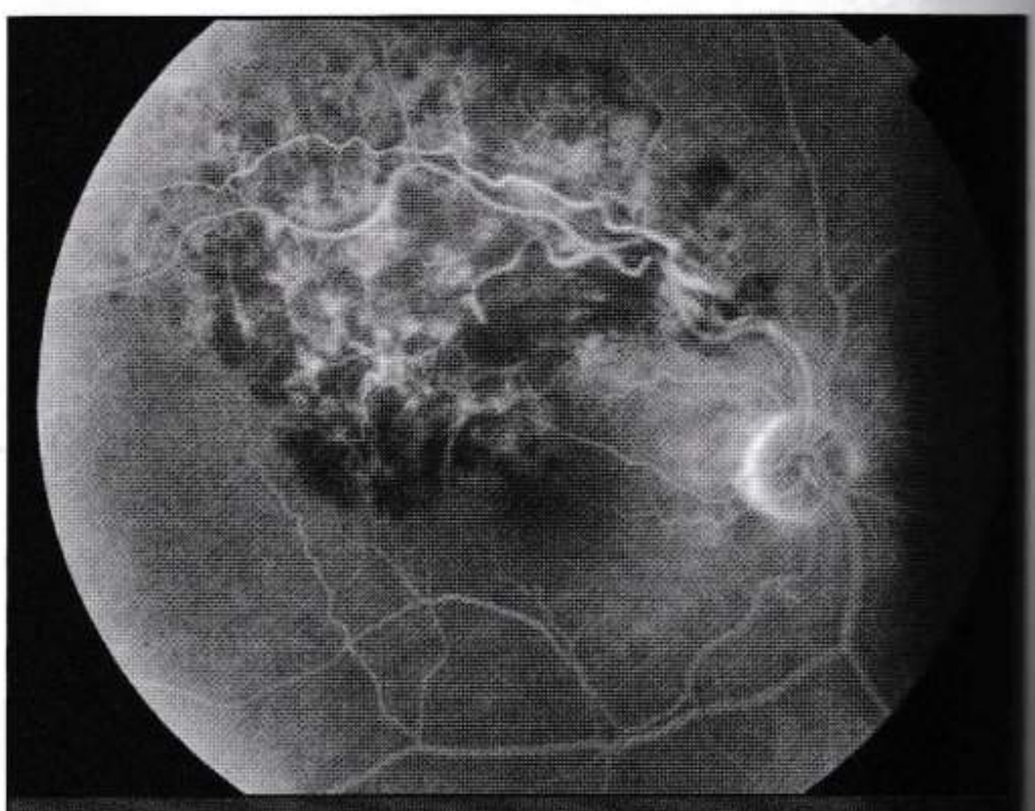
- Loss of vision is due to
  - Most common cause – Macular edema

Macular edema in BRVO may benefit from Laser photocoagulation, contrary to CRVO.

  - Macular ischemia
- Neovascularization (NVI > NVE)



BRVO – Wedge-shaped distribution of hemorrhage



FFA showing superotemporal areas of hypofluorescence and some leaking vessels seen as hyperfluorescent area

EXTRA MILE

	Ocular Ischemic Syndrome (OIS)	CRVO
Laterally	80% unilateral	Usually unilateral
Age	50s–80s	50s–80s
Fundus signs		
Venous status	Dilated (not tortuous), beaded	Dilated and tortuous
Hemorrhages	Peripheral, dot, and blot	Nerve fiber layer, posterior pole
Microaneurysms	In midperiphery	Variable
Exudate	Absent	Rare
Optic disc	Normal	**Swollen**
Retinal arterial perfusion pressure	**Decreased**	Normal
Fluorescein angiography		
Choroidal filling	Delayed, patchy	Normal
Arteriovenous transit time	Prolonged	Prolonged
Retinal vessel staining	Arterial	Venous

CENTRAL RETINAL ARTERY OCCLUSION (CRAO)

Retinal artery occlusion (RAO) can result from diseases affecting vessels from common carotid artery to arterioles causing infarction of inner retina and retinal ischemia.

Causes

- Atherosclerosis at level of lamina cribrosa – due to hypertension is the **most common**[Q] etiology – 80%
- **Carotid artery emboli** – (as ophthalmic artery is a branch of ICA) 20%
  - Hollenhorst plaques[Q] – cholesterol emboli seen at arteriolar bifurcations
  - Calcific emboli – on or close to the optic disc
  - Fibrin – platelet emboli
- Giant cell arteritis (GCA) – CRAO with anterior ischemic optic neuropathy (AION) – 1% to 2%
- Susac syndrome[Q] – CRAO (+) sensorineural hearing loss (+) encephalopathy
  (retinocochleo cerebral vasculopathy)

Clinical Features

- More common in males, >40 years of age
- Presents with unilateral, sudden (within seconds) painless[Q] loss of vision, except in GCA (painful)

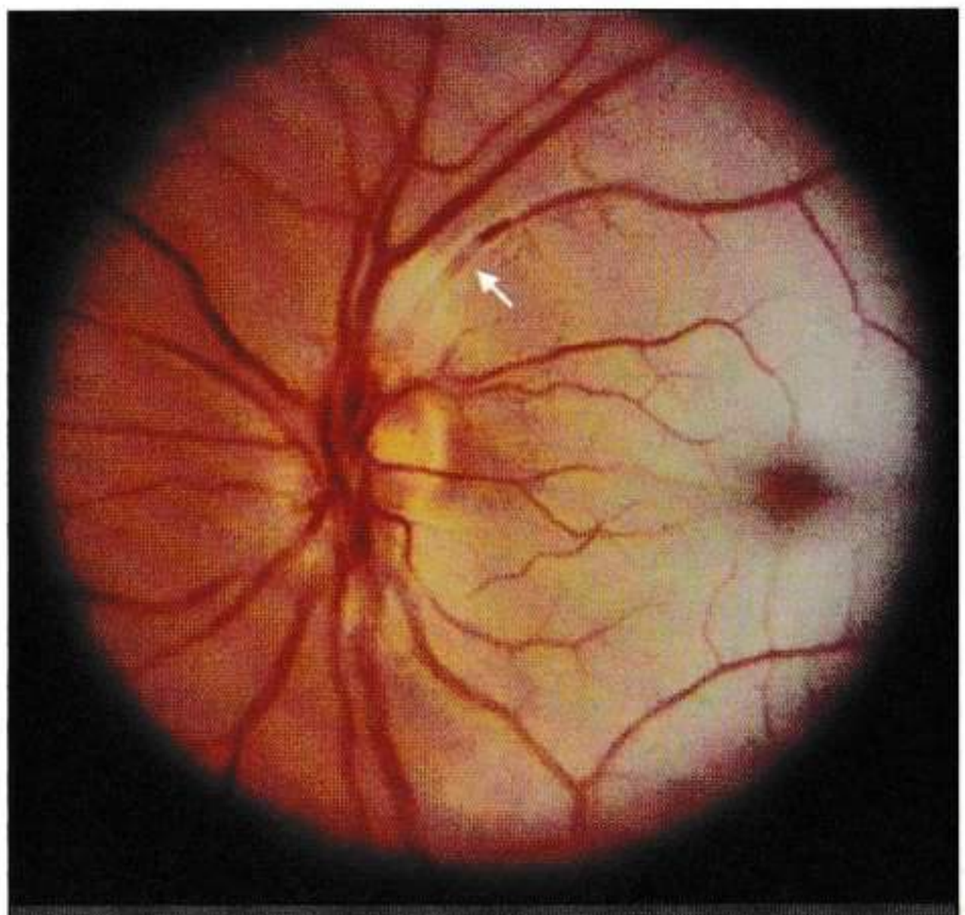
> Vision may be preserved in patients with a patent cilioretinal artery
> Amaurosis Fugax – transient loss of vision due to acute retinal ischemia, usually due to an emboli

- **RAPD**[Q] may be seen.

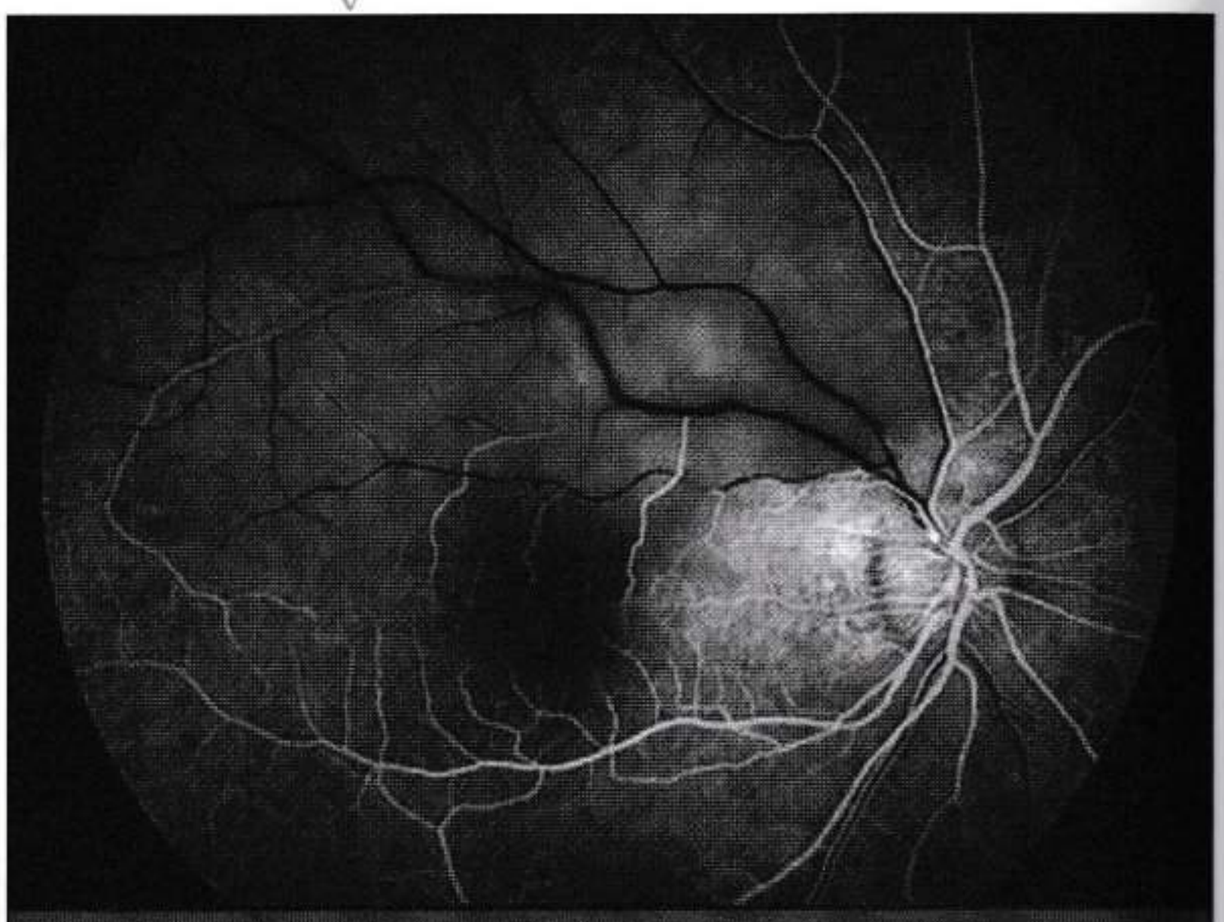
Fundus

- **Consecutive optic atrophy** – most common sign in chronic cases
- Rubeosis iridis (NVI) – seen after 6 weeks – earlier than CRVO
- Neovascularization of retina is rare – 2% patients
- **Cattle-Trucking/Box-caring**[Q] **fundus** (20% cases)–segmentation of blood column in veins and arteries due to narrowing/attenuation of vessels

- Cloudy white appearance – due to retinal edema (58% cases)
- **Cherry red spot**[Q] **at Macula** (90% cases) – occurs due to collection of fluid or metabolites in the **Ganglion cell layer**[Q] of retina, causing retinal opacity. The fovea shines with red color as ganglion cell layer is absent here and thus choroidal red reflex is visible – **earliest sign**. absent in ophthalmic artery obstruction



Box caring (white arrow) with retinal clouding and cherry red spot at macula



FFA – showing BRAO, with hypo-fluorescence of the involved segment due to blockage by edema and lack of superior arterial filling

Mnemonic

Causes of Cherry red spot[Q] **at Macula**

Cherry – **C**RAO[Q]
Trees – **T**rauma (Blunt)[Q]
Never – **N**eimann-Pick disease[Q]
Grow – **G**M1 gangliosidoses[Q]
Tall in – **T**aySach's disease[Q]] GM2 gangliosidoses[Q]
SAND – **S**andhoff's disease[Q]]

Mud – **M**etachromatic leukodystrophy[Q]
Multiple sulfatase deficiency[Q]
& **Grime** – **G**aucher's disease[Q] (only Type 2, not in Type 1 & 3)

Treatment

As most occlusions are incomplete, **treatment** is successful **within 24–48 hours** from onset of occlusion

↓

If complete occlusion, 97 minutes is Retinal ischemia time

↓

If >4 hours of complete occlusion, irreversible damage occurs to retinal tissue – permanent visual loss

- **Ocular massage** – to cause changes in arterial flow and dislodge emboli
- **Reduction of Intra-ocular pressure (IOP)**
  - Intravenous acetazolamide, mannitol or anterior chamber paracentesis (aspiration of aqueous)
- **Vasodilatation** – sublingual isosorbide nitrate inhalation of carbogen (95% O_2 + 5% CO_2)
- Transluminal Nd: YAG laser embolysis
- Thrombolysis – Intra-arterial streptokinase, urokinase, t-PA

RETINOPATHY OF PREMATURITY

Pathology

Normal retinal vascularization progresses in-utero from the disc margin (16 weeks), reaches the nasal ora serrata (32–36 weeks) and then temporally (by 39–41 weeks)

↓

Thus, **in premature** infants – retina remains incompletely vascularized in the peripheral region

↓

After birth – the differentiating retina becomes ischemic and hypoxic with VEGF up regulation and neovascularization of the peripheral avascular retina

Staging (International Classification of ROP)

EXTRA MILE

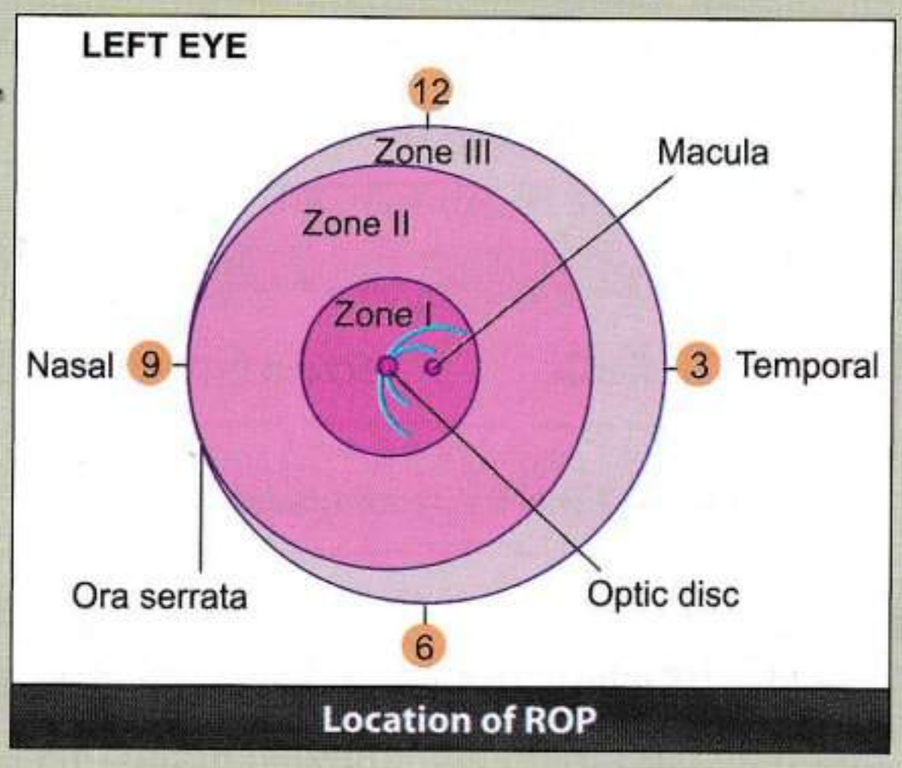
Staging of ROP

Location of the disease - Zones are centered around the optic disc and not the macula

Zone I (innermost) is a circle, the radius of which extends from the center of the optic disc to twice the distance from the center of the optic disc to the center of the macula.

Zone II extends centrifugally from the edge of zone 1 to the nasal ora serrata.

Zone III is the residual crescent of retina temporal to zone 2.



Location of ROP

Extent of the disease

The extent of the retinal involvement is recorded as hours of the clock or as 30 degree sectors.

Stage of the disease

Stage 1 : A flat demarcating line is seen delimiting vascularized retina from the anterior avascular retina
Abnormal branching or arcading of vessels is seen leading up to the demarcation line

Stage 2 : The demarcation line develops into a 'ridge'

Stage 3 : Extra-retinal neovascularization into the vitreous is seen with the development of abnormal shunt vessels at the ridge

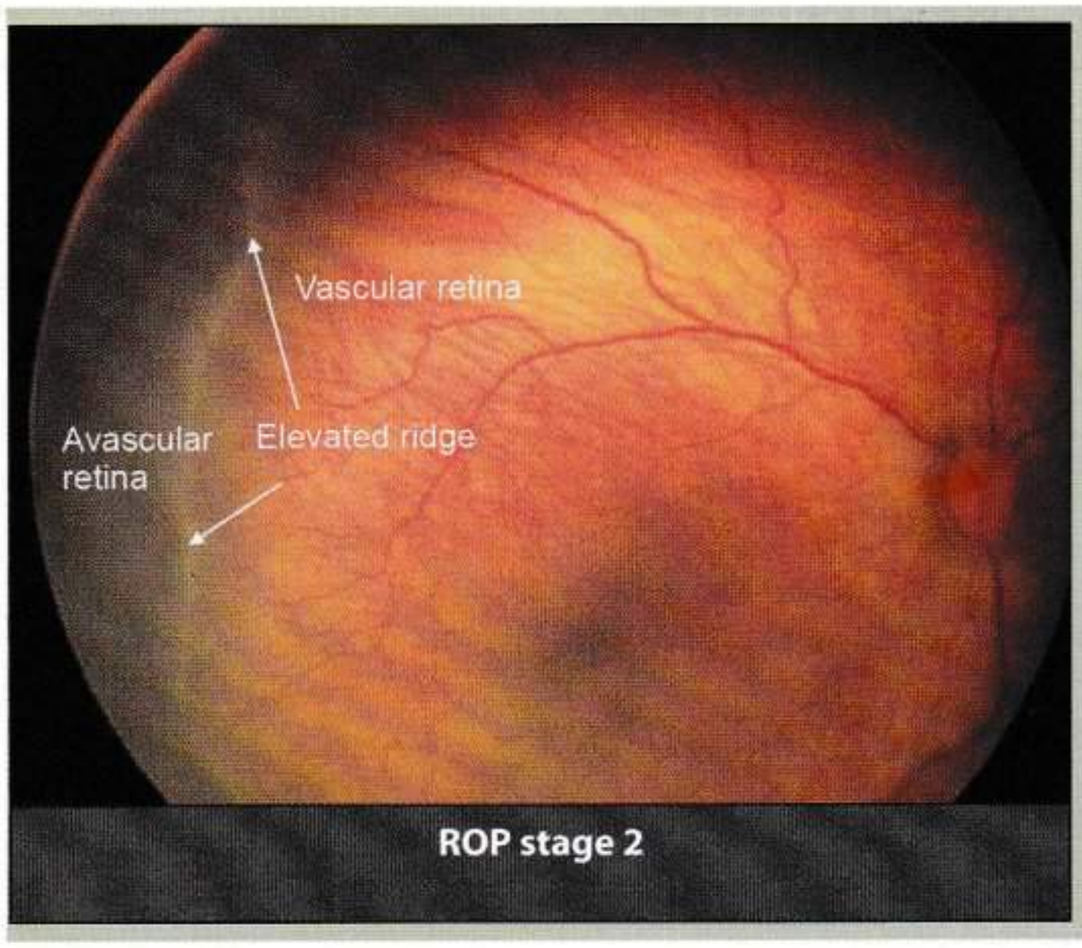
Stage 4 : ROP associated with retinal detachments

4A : extrafoveal

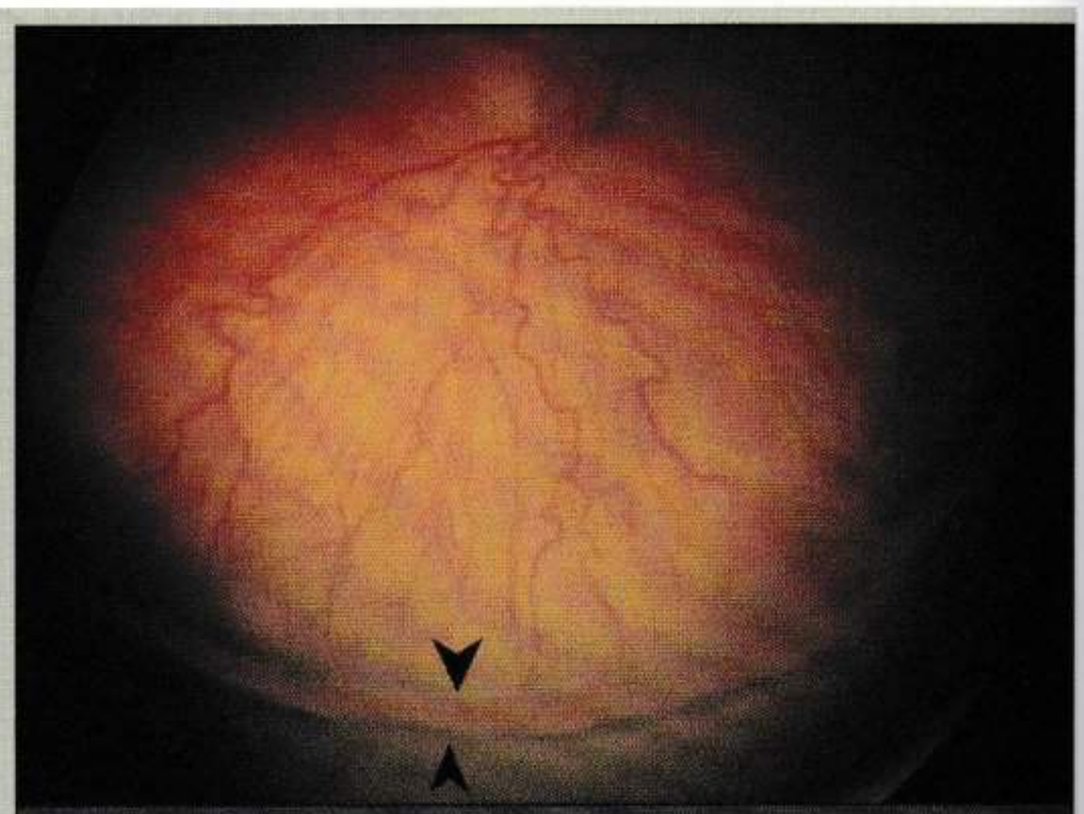
4B : involving the macula

Stage 5 : Total retinal detachment is usually tractional and funnel shaped and presents as a leucocoria or white pupillary reflex along with anterior segment changes such as corneal edema and angle closure glaucoma

Contd...



ROP stage 2



ROP stage 3 - new blood vessels grow along the ridge into the vitreous

Management

Identification of high risk cases

- Preterm infants born <34 weeks[Q] of gestational age
- Birth weight <1750 grams[Q]
- Preterm infants 34–36 weeks of age with risk factors[Q] (prolonged oxygen therapy[Q], respiratory distress syndrome, sepsis)

↓

SCREENING[Q]

Infants born ≥ 28 weeks and ≥ 1200 grams	Infants born < 28 weeks or < 1200 grams
↓	↓
Screen first **after 4 weeks** of chronological age/birth	Screen first **within 2-3 weeks** of chronological age/birth

↓

TREATMENT is recommended in

Threshold disease	**Pre-threshold type 1 ROP**
Atleast 5 contiguous or 8 cumulative noncontiguous clock hours of stage 3 ROP in zone 1/ zone 2 in presence of plus disease *(defined by CRYO-ROP study)*	• Zone 1, any Stage, plus disease • Zone 1, Stage 3 • Zone 2, Stage 2/3, plus disease *(defined by ETROP study)*

↓

PLUS disease: refers to venous dilatation and arteriolar tortuosity at posterior pole in at least 2 quadrants

↓

How to treat

Laser photocoagulation of the entire avascular retina upto ora serrata
(Diode-red laser : 810 nm wavelength is preferred)
or
by lens sparing PPV for Tractional RD

Extra Mile

- **Aggressive-posterior ROP (AP-ROP) – Rush disease**
- Rapidly progressive to Stage 5, posterior location, prominent plus disease, abnormal CLOSED loop vessels (not the normal dichotomous branching)
- Pupil in premature infants is dilated with 0.5% cyclopentolate and 2.5% phenylephrine drops
- If pupils do not dilate - suspect presence of Tunica vasculosa lentis
- Screening to be terminated with full retinal vascularization or with regression of ROP
- Around 80% cases may resolve themselves with restoration of the normal vascularization (Pre-threshold type 2 ROP)[Q]

*All the Guidelines listed here have been recommended by IAP followed in Indian scenario (other places guidelines listed are from AAP)

RETINAL TELANGIECTASIA

Idiopathic Macular/Juxtafoveal/Parafoveal Retinal Telangiectasia

Idiopathic, affecting the capillary bed
Histologically, NOT a true telangiectasia, rather consists of structural vessel abnormalities like loss of pericytes and deposits of excess basement membrane[Q]
Subdivided into

Group 1	Group 2	Group 3
Unilateral/Males	Bilateral	Bilateral
Parafoveal involving temporal macula[Q]	Parafoveal involving temporal macula	Perifoveal
Exudation present	Choroidal neovascularization and non-exudative Most common and has worst visual prognosis	Capillary occlusion

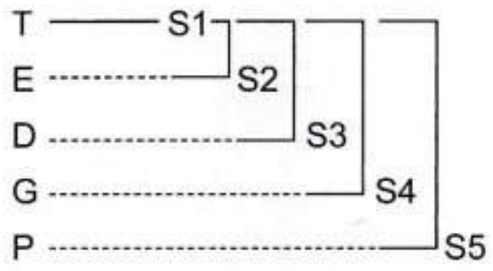
Coat's Disease

It is an idiopathic retinal telangiectasia, with onset in children (around 5 years of age), more common in Males[Q].

A mutation on NDP gene on chromosome Xp11.2 may be responsible

Presentation

- Unilateral[Q], painless visual loss (43%), strabismus (23%), leukocoria (20%)
- Signs
  - Telengiectasia
  - Localized, yellow, subretinal exudation
  - Exudative retinal detachment
  - Total retinal detachment with glaucoma
  - Phthisis bulbi



MISCELLANEOUS CONDITIONS

Radiation Retinopathy	Develops following treatment of intraocular tumors by Brachytherapy or external beam irradiation of other malignancies Presents with capillary nonperfusion, microaneurysm, papillopathy and proliferative retinopathy
Purtscher retinopathy	Occlusion and ischemia of retinal capillaries **associated with** • Blunt trauma – compressive injuries to head and chest • Acute pancreatitis[Q] • Embolism – fat, amniotic fluid, air • Thrombotic thrombocytopenic purpura • SLE • Bone marrow transplantation • Dermatomyositis • Chronic renal failure Presents with sudden visual loss with cotton wool spots (white patches) around a normal optic disc.

Valsalva retinopathy	Sub – internal limiting membrane hemorrhage at the macula due to perifoveal capillaries rupture caused by sudden rise in venous pressure
Eale's disease	Triad of • Periphlebitis • Occlusion • Retinal Neovascularization – causes recurrent vitreous hemorrhage (most common cause) T/t – Steroids may be helpful in inflammatory stage and PRP helps once proliferation develops

ACQUIRED MACULAR DISORDERS

Evaluation of Macular Disease

Symptoms

- Blurring of vision (central vision) and acquired hypermetropia
- Metamorphopsia – distortion of perceived images
- Micropsia or macropsia – due to spreading apart or crowding together of foveal cones
- Acquired color blindness – usually blue-yellow
- Positive Central Scotoma[Q]

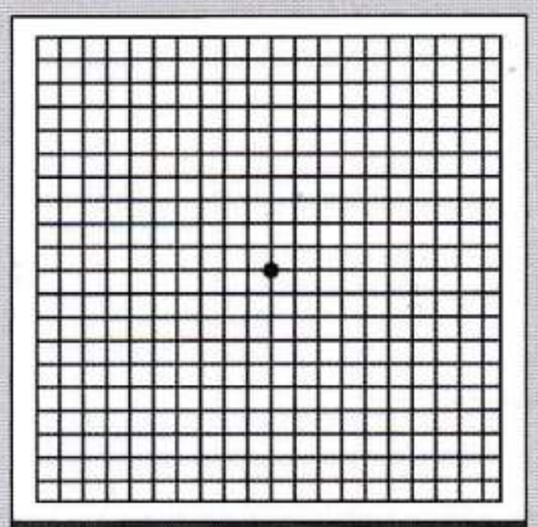
Macular Function Tests (MFT)

MFT with Clear media	MFT with Hazy media
• Visual acuity measurement • Contrast sensitivity • Slit lamp biomicroscopy • Photostress test • FFA • OCT • Amsler Grid	• Maddox rod test • Focal/Multifocal ERG • Laser interferometry (Li) • Potential acuity meter test (PAM) • B Scan • Entoptic phenomenon • Visual evoked potential

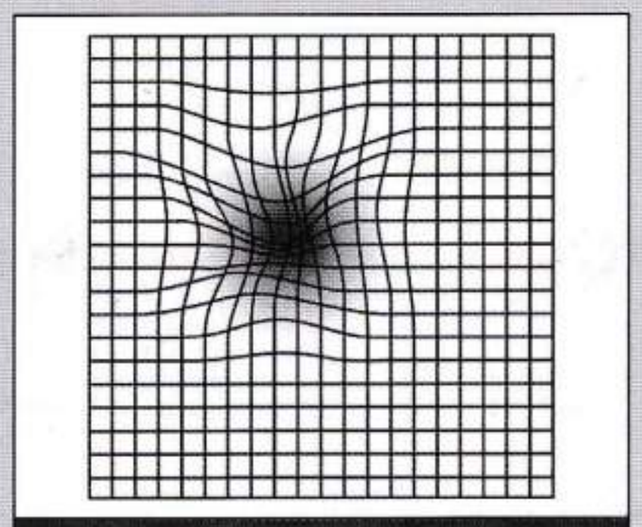
(All tests have been described elsewhere in relevant topics)

AMSLER GRID

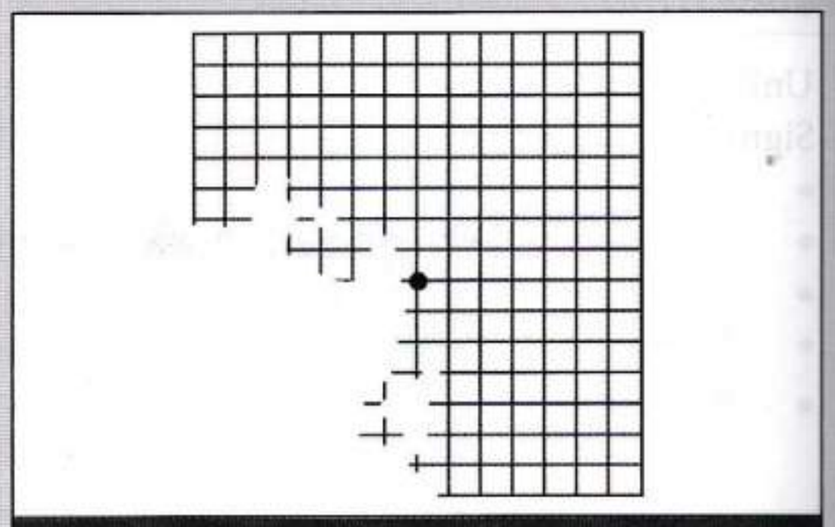
- It consists of square chart, divided into 400 5x5 mm squares to be held at 30 cm
- Evaluates the **central 20°** of the visual field



Amsler's grid



WAVY lines – Macular disease



Missing lines – optic neuropathy/Glaucoma/RP

EXTRA MILE

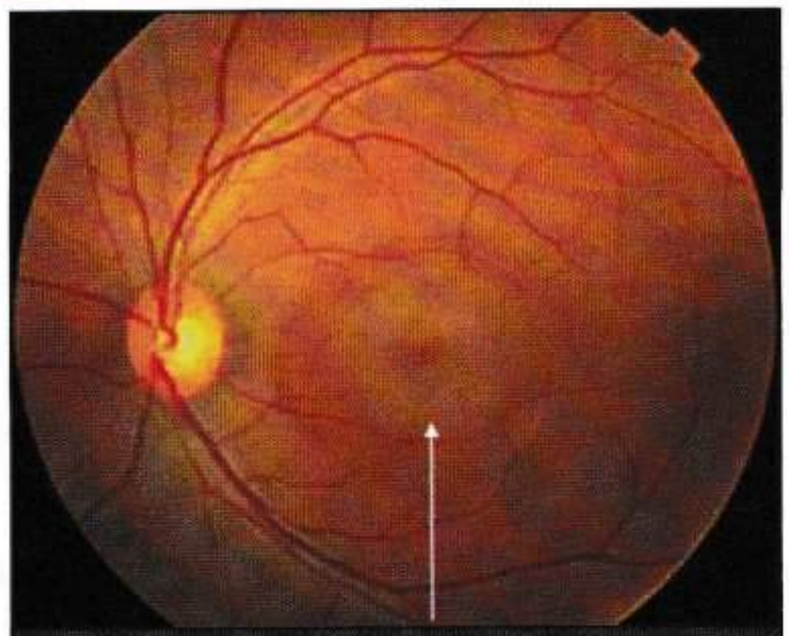
Entoptic Phenomenon (EP)

Visual perceptions that have their origin in the structure of an observer's eye

- Purkinje vascular EP - images of retinal vessels perceived if light thrown on a closed eyelid
- Flying spot/Blue field EP - images of flowing leukocytes in capillaries when blue illumination is used
- Haidinger's brushes -based on polarization of light by xanthophyll pigment at macula

CENTRAL SEROUS RETINOPATHY/ CHORIORETINOPATHY (CSR)

CSR is an idiopathic, localized shallow neurosensory (NSR) detachment[Q] at the macula due to collection of fluid in the subretinal space – usually **Unilateral**.



Round/Oval macular edema

Pathogenesis

Hyperdynamic choroidal circulation and choroidal vascular hyperpermeability

↓

Increase in hydrostatic pressure in choroid

↓

Breakdown of the retinal pigment epithelium[Q] (RPE) and RPE pump failure

↓

Leaked fluid from choroid collects in **subretinal space**[Q]

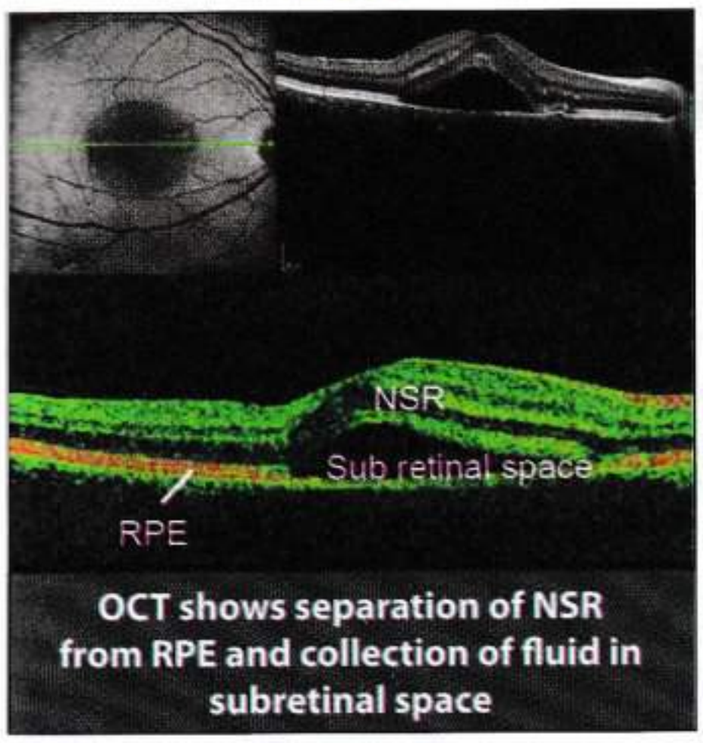
Risk Factors

- Male between 25 and 55 years[Q] of age
- Helicobacter pylori infection
- Type A personality[Q]
- Cushing syndrome
- Psychological stress
- External corticosteroid administration[Q]
- SLE
- Pregnancy

Management

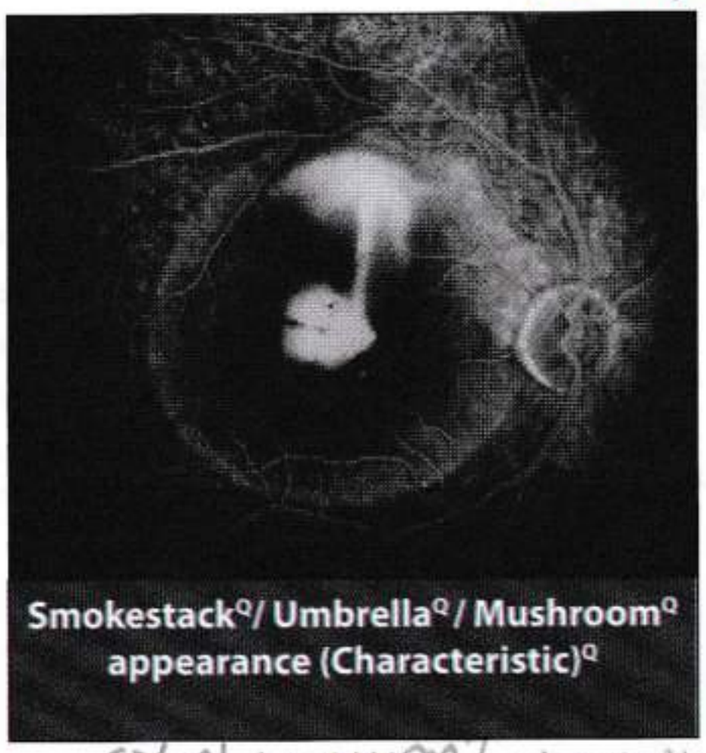
Patient presents will all the symptoms of macular disease described previously. CSR is confirmed by

↓ ***OCT***



OCT shows separation of NSR from RPE and collection of fluid in subretinal space

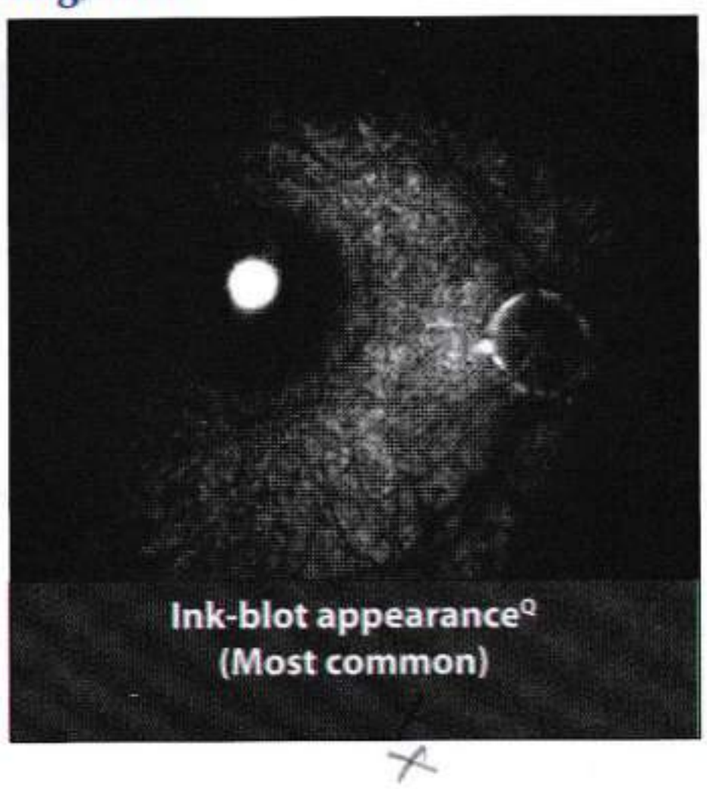
↓ ***(Due to pooling) FFA***



Smokestack[Q]/ Umbrella[Q] / Mushroom[Q] appearance (Characteristic)[Q]

[Most common] - Kanski

↓



Ink-blot appearance[Q] (Most common)

Treatment

- **Spontaneous resolution in most cases** – observation[Q]
- Steroids are contraindicated (risk factor)

- Argon or Diode laser photocoagulation
- Safety enhanced reduced fluence PDT (Photodynamic therapy)

↓

3 mg/m² VERTEPORFIN infused over 8 minutes

↓

Laser at 692 nm wavelength of light for 83 seconds (50 J/cm²)

Done if
- Serous detachment >3-4 months
- Recurrence in eyes with visual deficits
- Chronic signs develop as RPE degeneration
- Permanent visual field defect in fellow eye

CYSTOID MACULAR EDEMA

Pathogenesis

Disruption of normal inner blood-retinal barrier

↓

Leakage from perifoveal retinal capillaries and accumulation of fluid in outer plexiform layer (OPL) and inner nuclear layer (INL)[Q]

↓

Leads to
Retinal thickening at macula and loss of foveal depression
Formation of cystic spaces in NSR
Lamellar macular hole may occur

Risk Factors

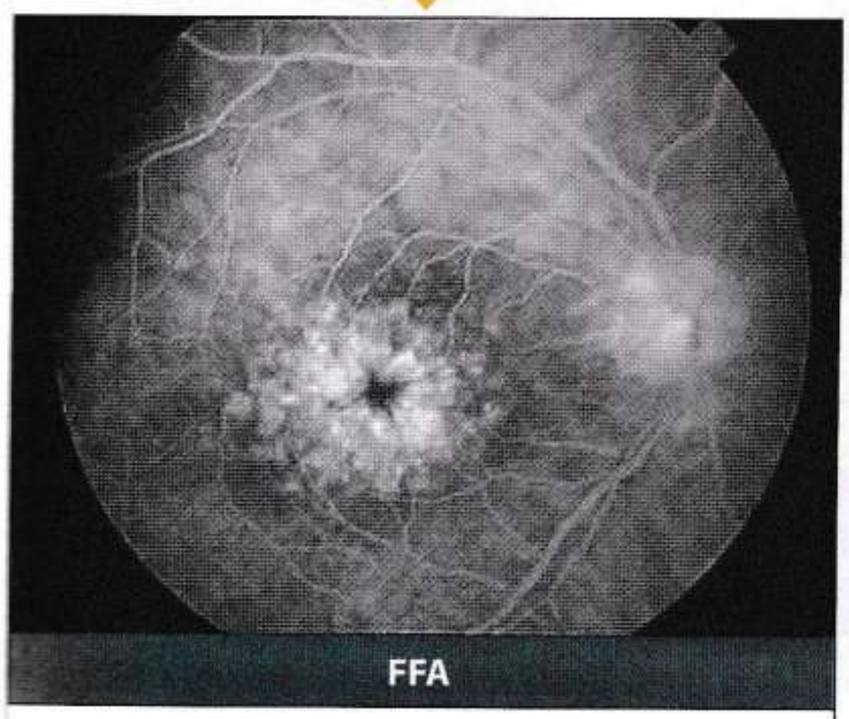
Mnemonic

RUN for PRIDE

R etinitis Pigmentosa (Dystrophies)	for	**P**rostaglandin E_2 analogues
U veitis		**R**etinal venous occlusion (CRVO, BRVO)
N iacin/Nicotinic acid		**I**rvin gass syndrome (cataract surgery complication)
		Diabetic retinopathy
		Epinephrine in aphakia

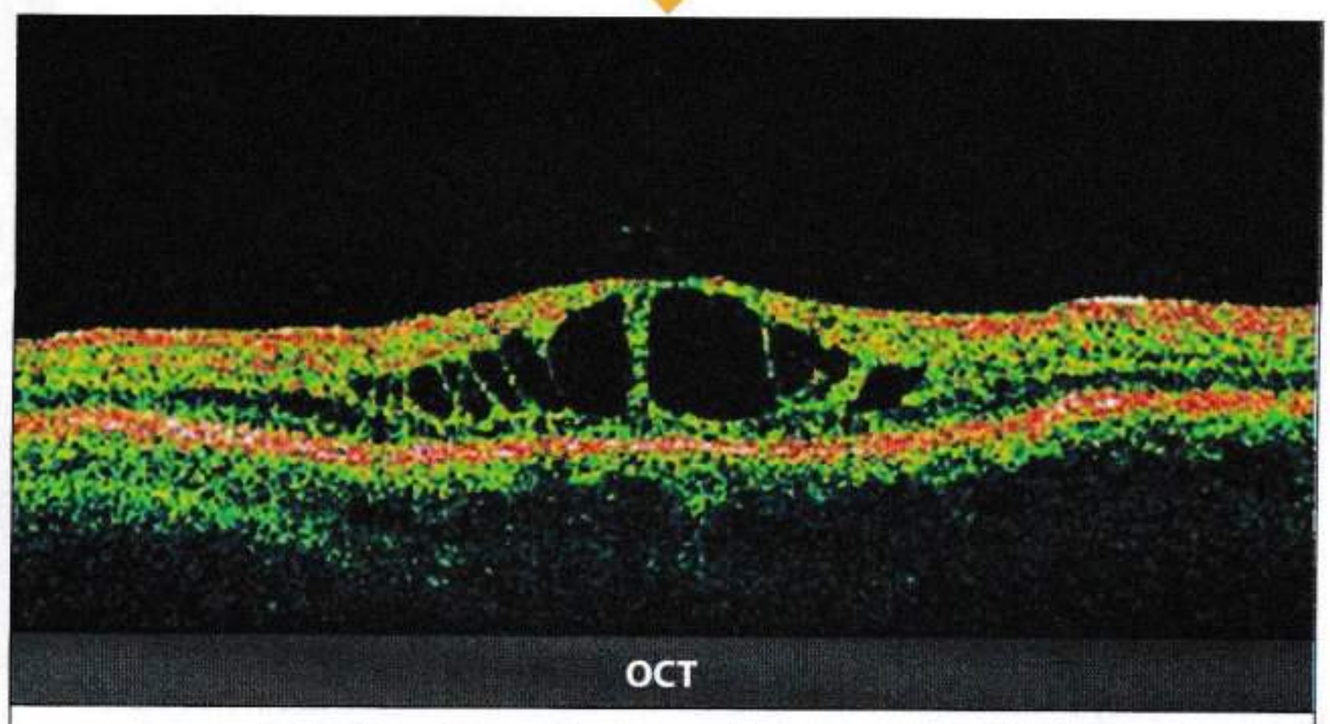
Management

Symptoms as of all macular disorders with honey comb maculopathy



FFA

Flower-petal[Q]/Petaloid[Q] appearance of hyperfluorescence **due to leakage**



OCT

OCT shows hyporeflective cystic spaces within NSR

Treatment

Steroids, Carbonic anhydrase inhibitors, Anti-VEGF agents, PPV for associated vitreomacular traction

AGE-RELATED MACULAR DEGENERATION (ARMD)

A degenerative disorder affecting the macula – the most common cause of irreversible visual loss in industrialized countries. It is common in individuals **>50 years** of age with a history of **smoking**[Q] (2 x risk), family history (CFH gene is protective, HTRA1 gene increases risk 5 times), blue color iris and certain dietary factors (high fat intake)

Classification

Dry/Non-neovascular/Non-exudative
90% cases, no/gradual loss of vision

- Early
- Intermediate
- Late

Early + Intermediate → DRUSEN[Q] and RPE abnormalities → Also know as Early ARM (age related maculopathy)

Late → Geographic atrophy of RPE

Wet/Neovascular/Exudative
10% cases, may present with sudden loss of vision

Pigment epithelial detachment (PED) and Choroidal neovascularization (CNV)[Q]

Geographic atrophy of RPE + Pigment epithelial detachment (PED) and Choroidal neovascularization (CNV)[Q] → Also known as Late ARM/advanced AMD

Signs and Treatment

ARMD disease process involves mainly the RPE – Bruch membrane – choriocapillaris complex along with outer segment of photoreceptors

Drusen - multiple intermediate sized

Non-neovascular ARMD/Dry ARMD

- **Drusen**[Q]

Extracellular eosinophilic deposits located between RPE and Bruch's membrane

HARD	SOFT
Well defined Small (<63 μm)	Less distinct Intermediate >63 μm and <125 μm or large (≥ 125 μm)

- **RPE abnormalities** – focal clumps/areas of hyperpigmentation or hypopigmentation of RPE
- **Geographic atrophy (GA)** – It is the end result of non-neonvascular AMD.
  A sharply delineated area (>175 μm in diameter) of attenuated or absent RPE, in which choroidal vessels are more visible

Treatment

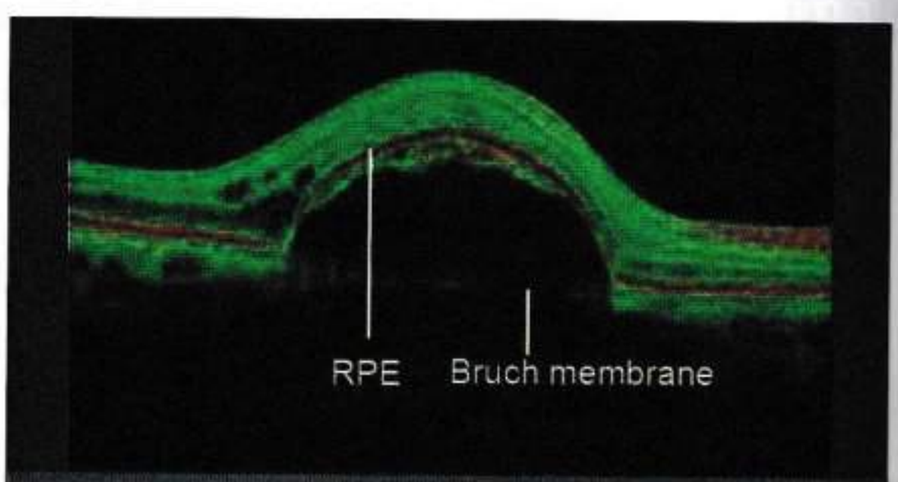
Should be done in Intermediate ARM only, to reduce progression to advanced AMD (GA or neovascular), by

Antioxidants supplementation	Recommended in
500 mg vitamin C 400 IU vitamin E 10 mg lutein 2 mg zeaxanthin 80 mg zinc 2 mg copper (as per **AREDS 2 study**)	• Individuals over 55 years (+) • One or more of ▪ One large soft druse ▪ Multiple intermediate sized soft drusen ▪ GA in one eye ▪ Advanced AMD in one eye

- β carotene usage may promote lung cancer in smokers, thus, its usage has been withdrawn (β carotene was advised as per AREDS)
- Laser photocoagulation of drusen – does not reduce risk of progression, though Drusen disappear

Neovascular ARMD

- **Pigment epithelial detachment** – due to reduction of hydraulic conductivity of a thickened and dysfunctional Bruch membrane, impeding fluid movement from RPE towards choroid



OCT showing RPE separation (red color layer) from Bruch membrane

Choroidal Neovascularization (CNV)

HALLMARK OF Neovascular AMD is Choroidal Neovascularization

Disturbance of Bruch's membrane (drusen/thickening of inner aspect)

↓

Break occurs (outer aspect)

↓

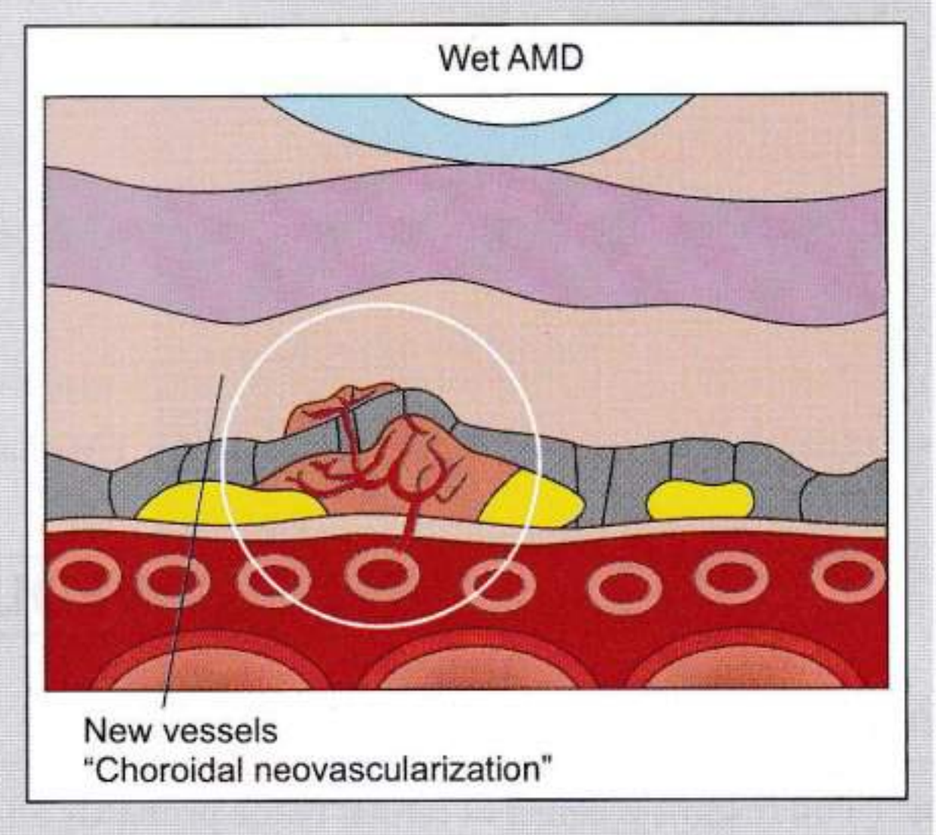
Buds of neovascular tissue from the choriocapillaris perforate the outer aspect of Bruch's membrane

↓

Fibrovascular complex (proliferates within the inner aspect)

↓

Disrupts normal architecture of RPE/Bruch's membrane/Photoreceptors



- CNV is the most common cause of visual loss in ARMD
- FFA is the GOLD standard investigation to confirm CNV
- OCT is the choice for monitoring CNV
- CNV on FFA can be of 2 types

Classical CNV
Mostly subfoveal, in the subretinal space

↓

IOC: FFA

Occult CNV
typically between RPE and Bruch membrane in sub RPE space

↓

IOC: ICGA

Treatment of CNV[Q]

Subfoveal or Juxtafoveal CNV

Intravitreal Anti VEGF drugs

- Drug/Treatment of choice[Q]
- Benefit in active disease
  - Leakage on FFA
  - Deteriorating vision
  - Enlarging CNV membrane
  - Presence of fluid/hemorrhage
- Contraindicated if Fibrosis/Scar

Photodynamic therapy (PDT) with use of Verteporfin (6mg/m^2), illuminated by light of 692 nm
Or
Transpupillary thermotherapy (TTT) – Diode laser of 810 nm

EXTRA MILE

Anti-VEGF Drugs

- RANIBIZUMAB (lucentis) – 0.5 mg/0.05 mL
  Monthly injections (at least 3)
- BEVACIZUMAB (Avastin) – 1.25 mg/0.05 mL
- AFLIBERCEPT (Eylea) – a soluble decoy receptor – 2 mg

↓

(All) Inhibit VEGF–A isoform

Indications for PDT

- Subfoveal, predominantly classic CNV
  ≤ 5400 µm with ≥ 6/60 visual acuity
- Purely occult CNV
- Presumed ocular histoplasmosis syndrome
- CSR
- Pathological myopia

- Extrafoveal CNV – Double frequency Nd:YAG Laser photocoagulation

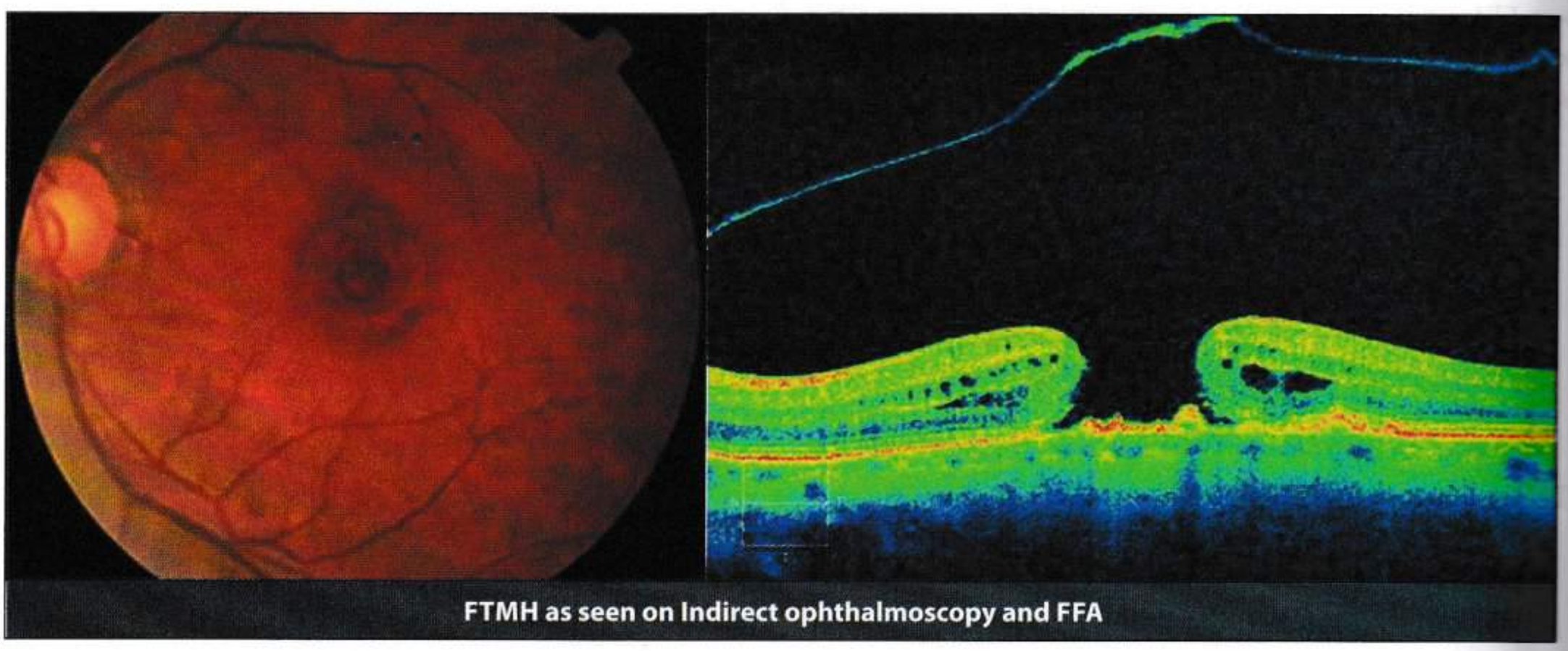
MISCELLANEOUS (MACULAR DISORDERS)

Macular Hole (FTMH)

- Full thickness defect of retinal tissue primarily affecting 'Foveola'

Diagnosis

- OCT – Gold standard
- WATZKE – Allen test – differentiates a lamellar/pseudohole
- FFA – RPE atrophy seen with FTMH



FTMH as seen on Indirect ophthalmoscopy and FFA

Grading

Correlation between commonly used clinical macular hole stages and the international vitreomacular traction study (IVTS) classification system for vitreomacular adhesion, traction, and macular hole

FTMH stages in common use	IVTS classification system
Stage 0	VMA
Stage 1: impending macular hole	VMT
Stage 2: Small hole	Small or medium FTMH with VMT
Stage 3: Large hole	Medium or large FTMH with VMT
Stage 4: FTMH with PVD	Small, medium or large FTMH without VMT

FTMH = full-thickness macular hole; PVD = posterior vitreous detachment; VMA = vitreomacular adhesion; VMT = vitreomacular traction

Epimacular Membrane

Epimacular membrane is also known as '**cellophane maculopathy**' – a sheet like fibrovascular structure that develops above retinal surface.

Angioid streaks

Angioid Streaks

- Crack like dehiscences in Bruch membrane and RPE
- **Peau d' orange** appearance or 'Spider Web' appearance
- **Causes**

Mnemonic

PEPSI
- **P**seudoxanthoma elasticum
- **E**herDanlos syndrome
- **P**aget's disease
- **S**ickle cell disease
- **I**diopathic

Hypotony Maculopathy

- Maculopathy developing in eyes with IOP less than 5mmHg[Q] – Hypotony
- **Presentation**
  - Chorioretinal folds radiating from Optic disc
  - Reduced axial length on A scan
  - B scan – choroidal effusion
- **Causes:**
  - Excessive drainage after glaucoma surgery (**bleb leakage**) – most common cause
  - **Penetrating** trauma or **cyclodialysis** cleft
  - Chronic uveitis – due to impaired ciliary body function and cyclitic membrane
  - Retinal detachment

Solar Retinopathy

Appearance of a transient (weeks) yellow or red foveolar spot within 1-4 hours of solar exposure, with a small central scotoma (loss of central vision). It may progress to lamellar hole
Visual acuity returns to normal within 6 months.

HEREDITARY FUNDUS DYSTROPHIES

Hereditary fundus dystrophies are a group of disorders primarily involving **RPE-photoreceptor-choriocapillaris** complex, with **Rod or Cone cell degeneration** leading to visual loss.

Rod Cells	Cone Cells
120 million Maximum in **Perifoveal area** (mid-peripheral retina) Responsible for peripheral vision/night vision/**scotopic** vision Dysfunction leads to poor vision at night (**Nyctalopia**) followed by peripheral field loss	**6.5 million** Maximum at the **Fovea** Responsible for day vision/**photopic vision** Dysfunction leads to problems in color vision (Dyschromatopsia), in day vision (**Hamaralopia**) and loss of central vision

Mnemonic

Causes of Nyctalopia – OMG! (CRAP)$_2$
- **O**guchi disease
- **M**yopia
- **G**yrate atrophy
- **C**ongenital stationary night blindness
- **C**ataract cortical
- **R**etinal detachment
- **R**etinitis pigmentosa
- **A**lbipunctatus—Fundus
- **A** vitamin A deficiency
- **P**henothiazine toxicity
- **P**ost refractive surgery

Mnemonic

Causes of Hemeralopia – $C_3 A_3 T_1$
- **C** →
  - Cone dystrophy
  - Central cataract (Nuclear and posterior subcapsular)
  - Cohen syndrome
- **A** →
  - Achromatopsia
  - Aniridia
  - Albinism
- **T** → Trimethadione

Hereditary dystrophies can be grouped on the basis of the apparent layer of involvement and inheritance pattern.

Autosomal Dominant (AD)	Autosomal Recessive (AR)	Variable Inheritance
Retinal generalized dystrophies		
	Stargardt disease (Juvenile macular dystrophy)	Retinitis pigmentosa[Q] (AR/AD/XLR)
	Fundus flavimaculatus	Progressive cone dystrophy (AD/XL)
	Leber congenital amaurosis	Alport syndrome (XL)
	Bietti corneoretinal crystalline dystrophy	Congenital stationary night blindness (XL/AD/AR)
	Familial benign fleck retina	Fundus albipunctatus (AD/AR)
	Oguchi disease[Q]	
Macular dystrophies		
Juvenile Best Vitelliform macular dystrophy	Sjogren-Larsson syndrome	
Pattern dystrophy		
North Carolina macular dystrophy		
Familial dominant drusen		
Sorsby pseudoinflammatory dystrophy		
Benign concentric annular macular dystrophy		
Dominant cystoids macular edema		
Vitreoretinal dystrophies		
Stickler syndrome[Q]	Favre-Goldman syndrome[Q]	Juvenile X-linked retinoschisis
Wagner syndrome (erosive vitreoretinopathy)		Familial exudative vitreoretinopathy (AD/XL)

RETINITIS PIGMENTOSA (RP)

Retinitis pigmentosa (RP) is the **most common hereditary fundus dystrophy**. It predominantly affects the **rod cells**[Q] with subsequent cone degeneration (Rod-cone dystrophy)[Q]

Inheritance Pattern

Autosomal Recessive[Q] – Most common[Q] AD - Kaneki!
Autosomal Dominant – Best prognosis—Rhodopsin gene[Q] mutation
X-linked Recessive[Q] – Worst prognosis[Q] and least common

Although typical RP is genetic, lack of family history is seen in 15–63% of patients (Simplex RP). ≤ 70% of such cases are AR

Symptoms

Bilateral[Q] involvement presenting during 2nd–3rd decades. Rod cell degeneration leading to

- **Nyctalopia**[Q]—defective vision in dim light (Earliest feature)[Q]
- Loss of peripheral vision[Q] presenting as

Mid—peripheral scotomas[Q]
(Superior visual field is lost earliest)
Coalesce to form Annular scotoma/Ring scotoma/Doughnut scotoma

↓

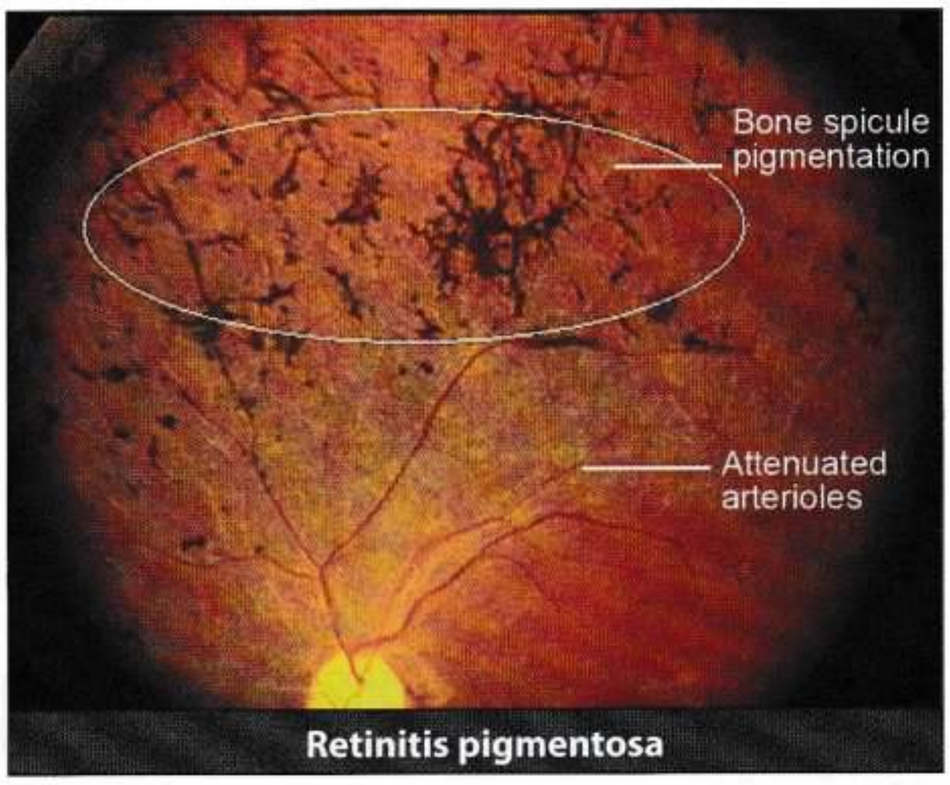
Only central vision remains—Tubular[Q] (Tunnel) vision

Annular/Ring scotoma are also seen in open Angle Glaucoma, Retinochoroiditis (posterior uveitis), retinal migraine and myopia

Signs

All fundus signs are initially seen to affect the Equatorial region, spreading to posterior pole and periphery

- **Arteriolar attenuation**[Q]
- **Pale and waxy optic disc**[Q]— Consecutive optic atrophy
- Intraretinal perivascular[Q] (around retinal veins) - **bone–spicule pigmentation**[Q]
- Female Carriers of XLR RP show a golden metallic (TAPETAL) reflex at macula.
- **ERG**[Q]**—Investigation of choice**—early disease shows reduced scotopic responses, later photopic responses and eventually ERG becomes extinguished
- EOG[Q] is subnormal
- Dark adaptation



Retinitis pigmentosa

Ocular Associations

- Posterior subcapsular cataract
- Open angle glaucoma
- Keratoconus
- Myopia
- Posterior vitreous detachment (PVD)

Treatment

Recent Advances

ARGUS II Retinal Prosthesis System

- USFDA has approved (2013), the first retinal implant, ARGUS II Retinal Prosthesis system. It replaces the function of degenerated cells in retina and restores central 20° of visual field. To be used for adults aged 25 years or more.

  (Isotretinoin, sildenafil and high dose vitamin E are medications with potential adverse effects in RP.)

Voretigene Neparvovoec-rzyl (Luxturna)

- Indication – Adeno-associated virus vector-based **gene therapy** indicated for the treatment of patients with confirmed biallelic **RPE65** mutation-associated retinal dystrophy
- Mechanism of action – a normal copy of the RPE65 gene is delivered **into the Sub-retinal space**, thus helping in phototransduction

RPE65 is normally produced in the retinal pigment epithelium cells and helps to convert

all-*trans*-retinol

↓ RPE65 isomerohydrolase

11-*cis*-retinol

↓

11-*cis*-retinal

- Dosage – 1.5×10^{11} vector genomes in 0.3ml
- Side effects – conjunctival hyperemia, Cataract, retinal tear, dellen, maculopathy

Systemic Associations of RP

Syndrome	Features
Kearns-Sayre syndrome	RP + Ocular myopathy + Heart defects
Lawrence Moon Beidl syndrome (most common)	RP + Obesity + Polydactyly + Mental retardation
Refsum's disease	RP + Polyneuropathy + Cerebellar ataxia
Usher's syndrome	RP + Labyrinthine deafness
Cockayne's syndrome	RP + Nystagmus + Ataxia + Deafness
Bassen-Kornzweig syndrome	RP + Abetalipoproteinemia + Acanthocytosis
NARP syndrome	Neuropathy + Ataxia + RP

Extra Mile

Atypical RP

Inverse RP[a]—Cone-rod dystrophy	AR	Cones are affected earlier leading to impairment of central vision.
Retinitis punctata albescens	AR	White dot or flecks scattered at equator sparing the macula
Sector RP	AD	Bilaterally symmetrical inferior quadrant involvement
RP 12		Preserved para-arteriolar RP
RDS/peripherin mutation		Macular atrophy occurs

CONGENITAL NIGHT – BLINDNESS DISORDERS

This is a group of disorders characterized by infantile onset nyctalopia and stationary/non-progressive retinal dysfunction.

Name	ERG	Other features
With normal fundi		
Congenital stationary night blindness (CSNB)	Negative (Schubert-Bornschein)	Most commonly – X linked (Xp11)
With abnormal fundi		
Oguchi disease	**Normal**	Defect in retinal circuitry not in visual pigment **Mizuo-Nakamura phenomenon** – fundus has a golden-yellow colour in light adapted state which disappears after dark adaptation
Fundus Albipunctatus	Absent Rod responses	Disorder of visual pigment regeneration
Enhanced S-cone syndrome	Only blue cone (S) responses – Negative ERG	RPE degeneration around vascular arcades and cystoids macular edema seen.

JUVENILE BEST MACULAR DYSTOROPHY

- It is an Autosomal dominant (**AD**)[Q] macular dystrophy caused by mutations of VMD 2 gene (11q13) which encodes **Bestrophin** protein

Clinical Features

- Presents in infancy or early childhood and usually **does not impair vision**
- **Vitelliform lesion**[Q]—yellow, egg-yolk like lesion at the macula

↓

Part of lesion resorbs causing Pseudohypopyon

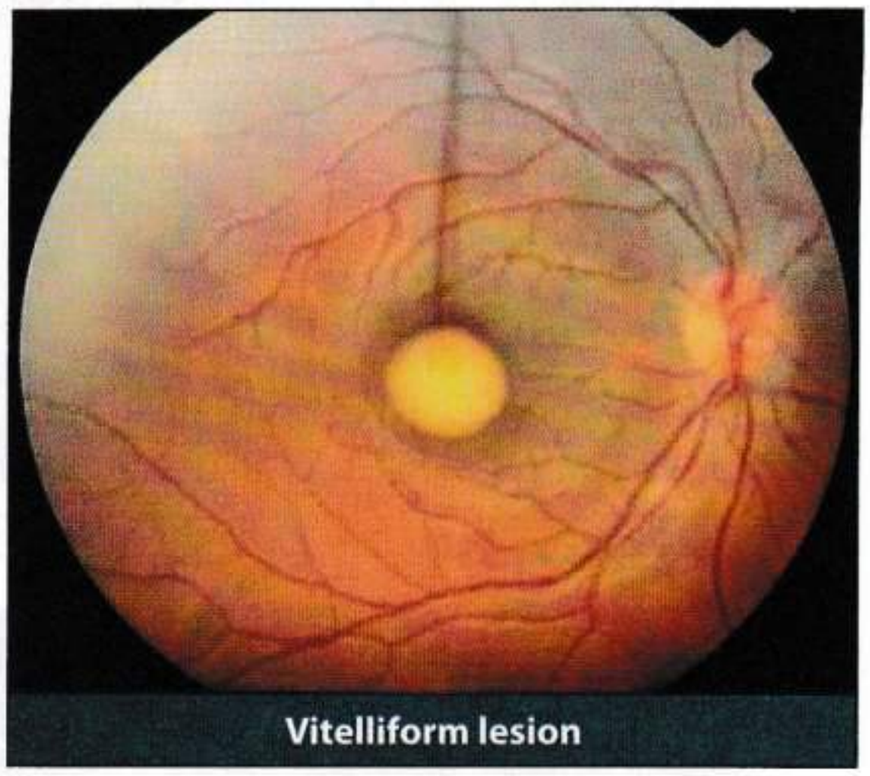
↓

Egg yolk scrambles—visual acuity drops
Vitelliruptive lesion

↓

Geographic atrophy ensues

- Lipofuscin accumulation occurs



Vitelliform lesion

Investigations

- **ERG** is characteristically **normal**
- **EOG** is always abnormal—**Investigation of Choice**[Q]
  Arden ratio is typically < **1.50/150%**.

Normal ERG with abnormal EOG[Q]—Best dystrophy[Q] or Pattern dystrophy

Other Dystrophies

- **STARGARDT'S disease**—most common macular dystrophy, **AR**, due to mutation of ABCA4 gene, presenting with bilateral loss of central vision with a Beaten—Bronze appearance of macula, bull's eye maculopathy and **dark choroid sign on FFA**.[Q]
- **Leber congenital amaurosis**—severe Rod-Cone dystrophy presenting in infancy or early childhood with reduced vision at birth and wandering nystagmus with oculodigital reflex
- **X-linked retinoschisis**—Bicycle wheel maculopathy presents with schisis (splitting) of the nerve fiber layer from the rest of NSR. (In acquired retinoschisis, splitting occurs at outer plexiform layer)
- **Stickler syndrome**—commonest inherited cause of RD in children presents with systemic features like facial anomalies (depressed nasal bridge, micrognathia), cleft palate or high arched palate, skeletal involvement (Joint hypermobility)

RETINAL DETACHMENT

RD is separation of the neurosensory retina (NSR) from the retinal pigment epithelium (RPE) resulting in collection of fluid in the sub-retinal space (SRS)

↓

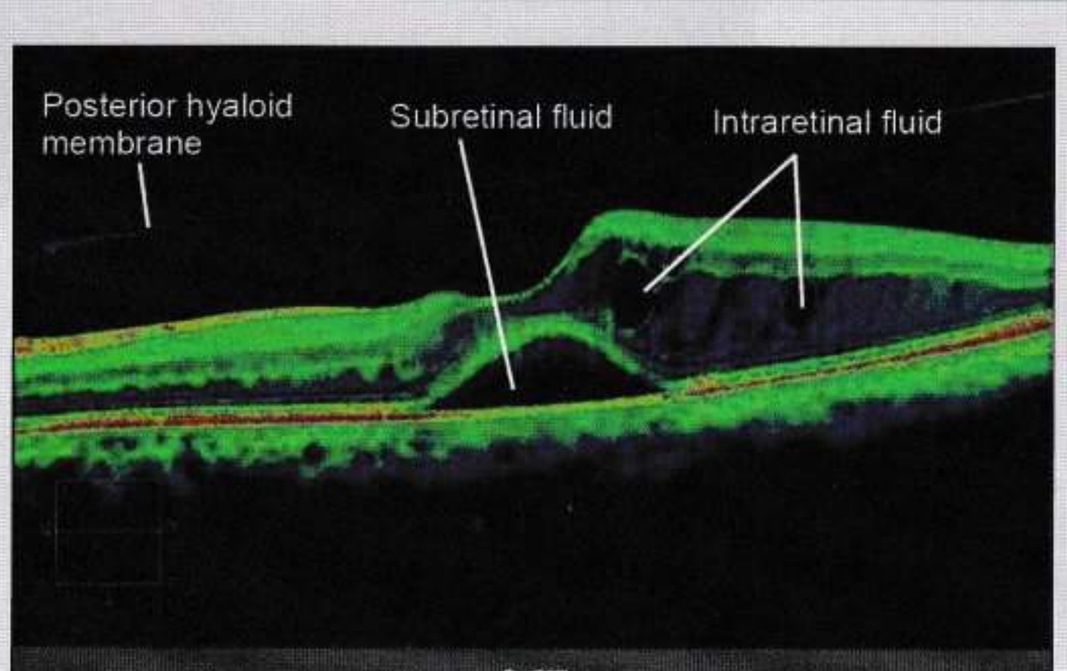
Primary RD → RHEGMATOGENOUS

Secondary RD → TRACTIONAL, EXUDATIVE

U-shaped tear with retinal detachment

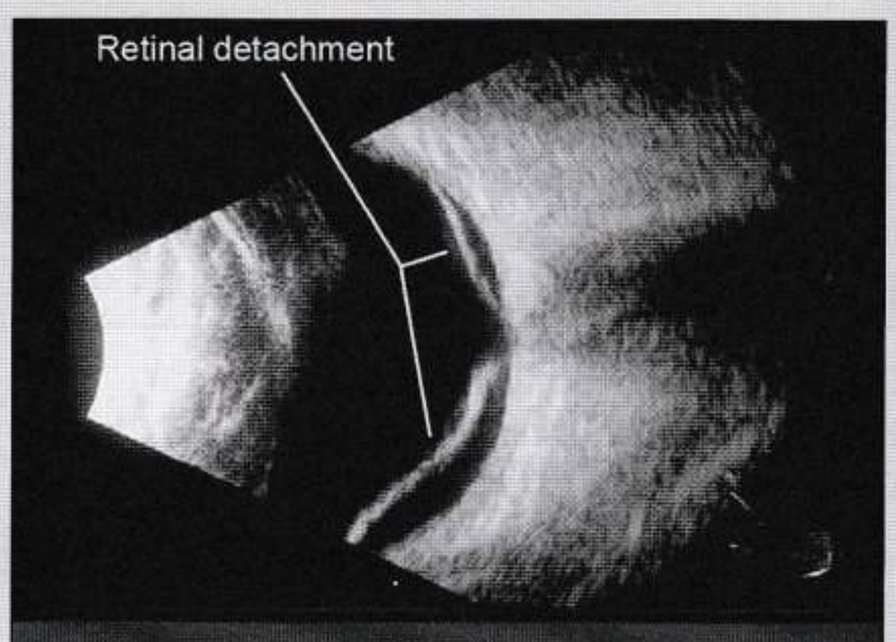
Grey/opaque colored retina due to edema indicating retinal detachment

INDIRECT OPHTHALMOSCOPY – Investigation of Choice for RD



OCT

Subretinal fluid with intraretinal cysts are seen along with detachment of neurosensory retina



B-scan

Retinal detachment

In early stages – detached retina assumes a white or grey opaque color secondary to intraretinal edema and the choroidal pattern of vessels is no longer seen.

In later stages with total retinal detachment, the retina is funnel shaped remaining attached at the optic disc and the ora serrata

Difference between Various Types of Retinal Detachment

Rhegmatogenous RD	Tractional RD	Exudative RD
Causes /Predisposing conditions		
Pathological myopia - **most common** Aphakia Lattice degeneration Snailtrack degeneration Degenerative (acquired) retinoschisis White with pressure and white without pressure Blunt ocular Trauma Cataract surgery (ICCE>ECCE)	Proliferative diabetic retinopathy (PDR) – **most common** Sickle cell retinopathy Retinopathy of prematurity (Stage 4 & 5) Eale's disease Penetrating ocular Trauma Toxocariasis	Choroidal melanoma – **most common** Toxemia of pregnancy Coats disease VKH syndrome Choroiditis, posterior scleritis Hypertension Central serous retinopathy

Contd...

	Rhegmatogenous RD	Tractional RD	Exudative RD
Pathogenesis	**Syneresis** (liquefaction) of vitreous occurs with age ↓ Leads to acute Posterior vitreous detachment (**PVD** – detachment of vitreous from the internal limiting membrane of the retina) ↓ Remaining attached vitreous exerts **Dynamic vitreoretinal** traction, i.e. vitreous pulls the retina ↓ as a result of traction **Breaks** (retinal tears) develop ↓ Break allows the liquid vitreous to seep inside the retina – fluid collects in the SRS leading to RD; **Breaks** (retinal holes) may develop due to associated pathological conditions causing atrophy of NSR ↓	NO breaks ↓ Due to **Static vitreoretinal traction** (caused by progressive contraction of fibrovascular membranes in areas of vitreo-retinal adhesion) ↓ Retina mechanically pulled away - RD ↓ Chronic, incomplete PVD also develops	NO breaks or Traction ↓ Due to various local and systemic causes leading to leakage of fluid from the vessels into the subretinal space ↓ RPE pumping of fluid into choroid overwhelmed ↓ Collection of subretinal fluid ↓ NSR pushed away - RD
Symptoms			
Photopsia – flashes of light – due to vitreoretinal adhesions leading to traction of the retina, irritating the neuroepithelium – Earliest symptom		May be seen occasionally	
Floaters (muscae volitantes) – perception of small flying black dot like opacities – due to vitreous opacities casting a shadow on the retina (**WEISS ring** – is a solitary floater which occurs due to PVD)		Absent	Absent
Loss of vision – Sudden and painless		Gradual and painless	Sudden and painless
Visual field defect – patient complaints of a **Curtain falling in front of the eyes**		Present	Present
Clinical features			
Extent of detachment			
Extends till ora serrata, has **CONVEX surface**		Does not extend till ora serrata, has a **CONCAVE** surface	Volume and gravity dependent, extension to ora is variable
Retinal Mobility			
Mobile retina with undulating folds or bullae		**Taut, Immobile** retina	Very mobile, smoothly elevated
Long-Standing cases (Signs of chronicity)			
• Retinal thinning (atrophy) • Subretinal demarcation lines (High water marks) – seen if RRD has been present for >3 months • Intraretinal cysts – seen if RRD persists for >1 year		Demarcation lines	None
Subretinal fluid			
Clear		Clear	May be Turbid **Shifting fluid – Hallmark** – shifts rapidly to dependent location with changes in head position
Shafffer sign – pigment in the anterior vitreous gives **Tobacco dust** appearance		Present in traumatic cases	Absent
Marcus gunn pupil/**RAPD** can occur		Present	Present

Proliferative Vitreoretinopathy (PVR)

It is the **most common complication** following a rhegmatogenous retinal detachment. It usually occurs following trauma or surgery for rhegmatogenous RD. It is caused by caused by epiretinal and subretinal membrane formation which reduce the retinal mobility. The scar tissue exerts traction on the retina and thus results in recurrence of RD – most common cause of treatment failure in RD.

It can be diagnosed on **B-scan USG** by the characteristic **Triangular sign**.

Prophylaxis

Prophylaxis can be done in cases of retinal breaks causing RD, if breaks (tear more dangerous than a hole) are located in the **Superotemporal quadrant**, associated with PVD or surrounded by large amount of subretinal fluid.

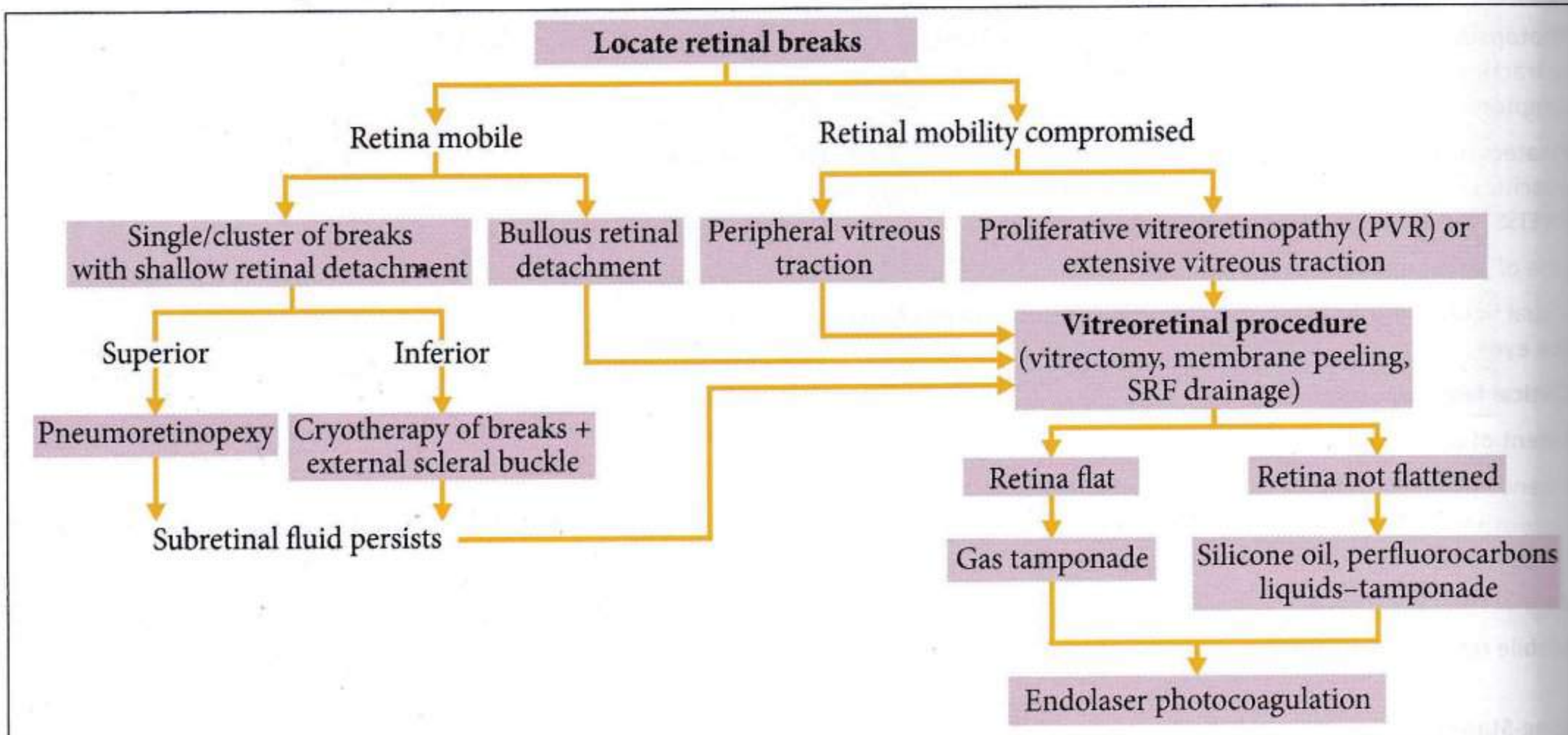
All U shaped tears and retinal dialysis should be prophylactically treated whether symptomatic or asymptomatic

Argon Laser photocoagulation preferred

- 200 micron spot size burns surrounding the lesion in two rows

Cryotherapy increases the risk of epiretinal membrane formation

Treatment



- **Pneumatic retinopexy** is an OPD proredure in which an interavitreal expanding gas bubble is used to seal a retinal break by **Tamponade**. The most frequently used gases are sulphur hexafluoride (SF_6) and the longer acting perfluoropropane (C_3F_8)

Gas	Average Duration	Average expansion
SF_6	12 days	Doubles
C_3F_8	38 days	Quadruples

- The basic **criteria** required for PR include the following:
  (1) presence of a single or multiple retinal breaks less than two clock hours
  (2) location of all retinal breaks in the **superior 8 clock hours** (2/3rd) of the globe; and
  (3) ability of the patient to maintain the proper head position for at least 16 hours a day for five days or more.
- **Silicone oil injection** in Vitreous cavity – offers the advantage of faster visual rehabilitation, but needs to be removed after 8–12 weeks, otherwise it may cause secondary glaucoma, cataract, etc.
- **Scleral buckling** – It is a surgical procedure where tamponading is achieved by suturing an explant (usually soft silicone) over the sclera creating an inward indentation. It thus closes the retinal breaks by attaching the RPE to the NSR and by reducing the dynamic vitreoretinal traction.

EXTRA MILE

LINCOFF rules

Rules to localize retinal break by observing the configuration of the retinal detachment.

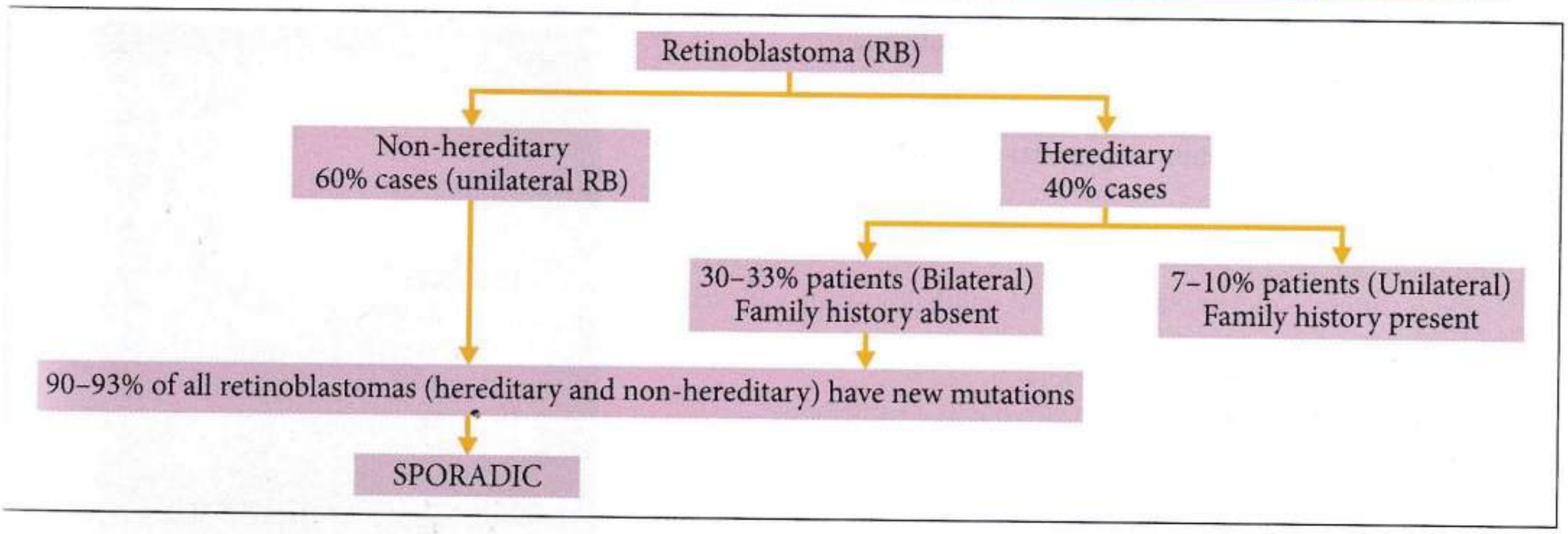
- Rule 1 – 98% breaks lie within one and a half clock hours of the highest border of the Superior detachment.
- Inferior breaks – higher side of the detachment indicates on which side of the disc an inferior break lies.
- Inferior bullae in a Rhegmatogenous retinal detachment originate from a superior break.

RETINOBLASTOMA

Retinoblastoma is the **most common primary intraocular malignancy** in childhood[Q].

It accounts for about 3% of all childhood cancers with an incidence from 1:15000 to 1:17000 live births.

Genetics



Hereditary/Germinal Retinoblastoma

- Occurs due to mutation of **RB1** (tumor suppressor gene) in all body cells – located on **13q14**[Q]

The inheritance of a single inactive allele of the RB1 gene (mutation occurring prior to first mitotic division of embryogenesis) confers predisposition to cancer – thus the inheritance is **Autosomal Dominant**[Q]

↓

but a second inactivating mutation is needed for retinoblastoma to occur phenotypically – thus it has a **Autosomal recessive expression**

↓

Knudson's two hit hypothesis[Q] – explains loss of heterozygosity by the second hit and thus the malignant transformation

- 85% of all heritable retinoblastoma patients develop bilateral[Q] eye tumors, but other 15% develop unilateral tumor (Unilateral retinoblastoma can be both hereditary and nonhereditary[Q])
- Around 2–5 years of age, 3% of these patients develop a primary (Not a metastasis from the eye) nonocular tumor – Pinealoblastoma or suprasellar primitive neuroectodermal tumor (PNET) – **Most common neoplasm encountered in association with retinoblastoma**[Q]
- **Most common secondary malignant neoplasm** – Osteosarcoma[Q]

Clinical Features

Most cases present within 3 years of age, with most common age of presentation being **18–24 months**

- **Leukocoria**[Q] (White pupillary reflex/Amaurotic cat's eye reflex) – **most common clinical feature**[Q] – 60% cases

Mnemonic

Causes of leukocoria[Q] – Please Take Extra 3(RC) Cans

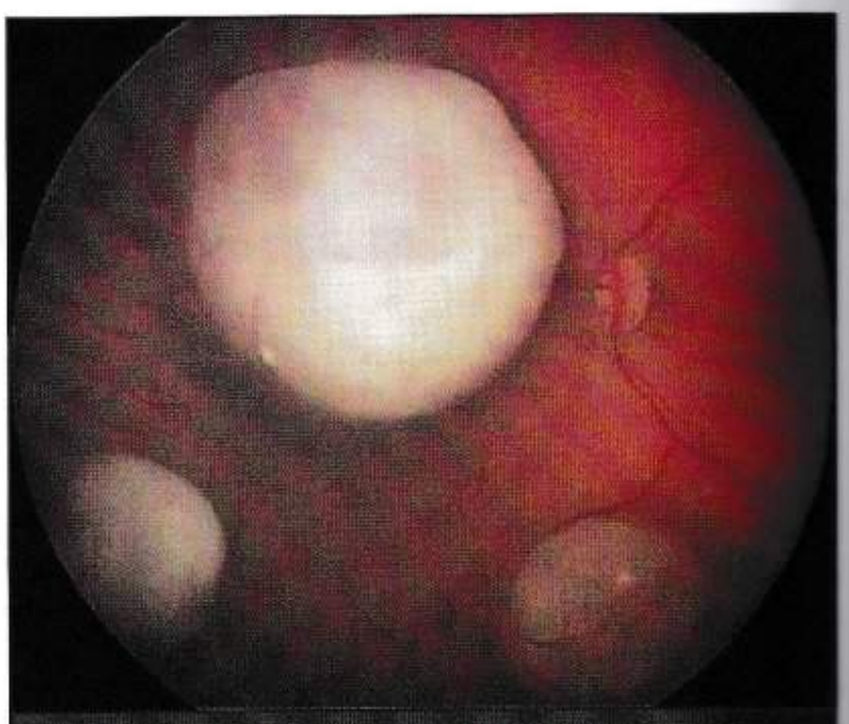
Please – PHPV
Take – Toxocariasis
Extra – Endophthalmitis
3R – ROP/RD/RB
3C – Coats disease/Coloboma/Cyclitic membrane
Cans – Central cataract
(All these are conditions are together known as **Pseudogliomas**. Coats disease is the most common cause)

Leukocoria

Left eye – white pupillary reflex

- **Strabismus** – 20% cases – most commonly **esotropia**[Q]
- Secondary glaucoma with buphthalmos
- Pseudouveitis
- Orbital inflammation mimicking orbital or preseptal cellulitis
- Proptosis
- Complicated cataract
- Retinal detachment
- Growth pattern – diagnosed by Indirect ophthalmoscopy with scleral indentation
  - Exophytic – grows toward choroid
  - Endophytic – projects into the vitreous as a white mass
- **Retrolaminar growth** – indicates poor prognosis as the lamina cribrosa offers maximum resistance to spread.

The most common route of spread is Direct[Q] – through the optic nerve and the sclera



Endophytic growth of retinoblastoma into the vitreous cavity

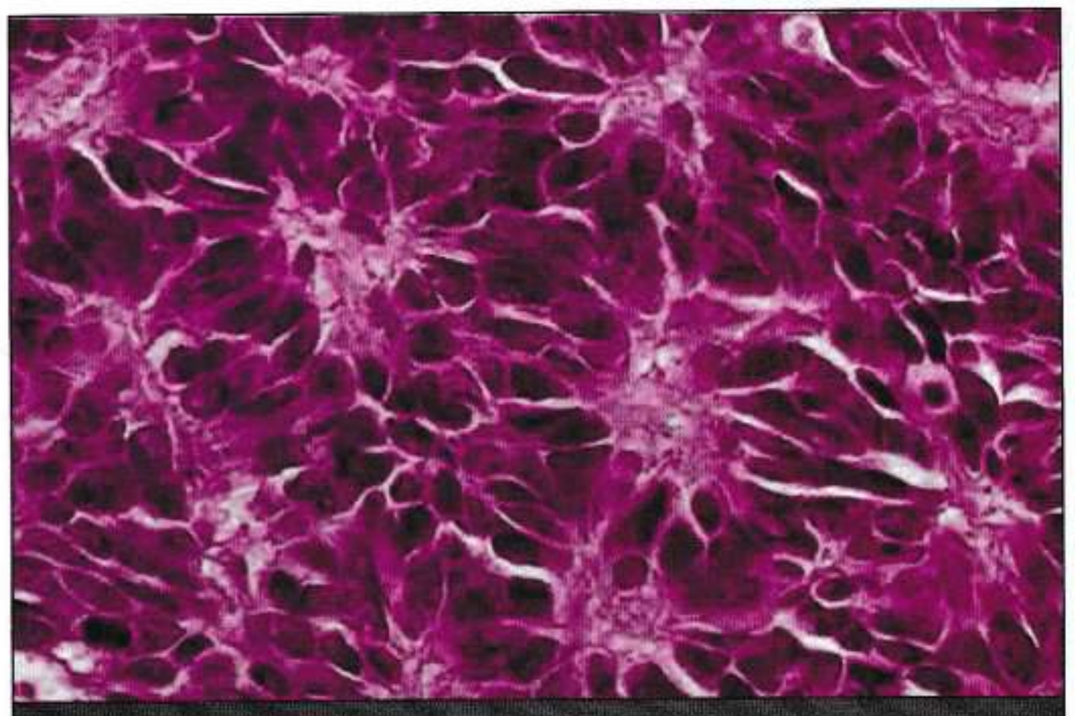
Investigations

- Red reflex testing with a direct ophthalmoscope – screening measure
- **B-scan USG** – used to assess the tumor size and presence of calcification
- **CT scan** – it can detect
  - Calcification
  - Extraocular extension
  - Intracranial metastasis and intracranial Pinealoblastoma
- **MRI** – detects extraocular metastasis
- Increased levels of LDH, NSE in aqueous
- **Biopsy** – after removal of the eyeball to confirm the diagnosis – biopsy sample is taken from the Optic nerve. **On histology** the following are seen
  - Flexner – Wintersteiner rosettes
  - Homer – Wright rosettes (Pseudorosettes – as they have eosinophilic processes)
  - Fleurettes

Foci of calcification visible in both eyes – Retinoblastoma is the most common cause of Intraocular calcification

Flexner –Wintersteiner rosettes

Central lumen surrounded by tall columnar cells with nuclei away from the lumen



Homer – Wright rosettes

Irregular ring of nuclei encompasses a central tangle of neural processes. No lumen is present

Classification

RPC-IRCH Classification of Retinoblastoma

Stage IA **IB**	• One/more lesion up to 3 DD in size/3 mm height • With vitreous seeds
Stage IIA **IIB**	• One/more lesion 4–6 DD in size/4–6 mm height • With vitreous seeds
Stage IIIA **IIIB**	• One/more lesion >6 DD in size/>6 mm height • With vitreous seeds
Stage IV	Extraocular spread confined to the orbit
Stage V	Distant metastasis

International Classification of Retinoblastoma (ICRB)

Group A	<3 mm in size, tumor away from the optic disc and macula
Group B	>3 mm in size, macular/juxtapapillary tumor with subretinal fluid
Group C	Subretinal fluid/vitreous seeding within 3 mm of tumor
Group D	Subretinal fluid/vitreous seeding >3 mm of tumor
Group E	>50% globe has been occupied, vitreous hemorrhage, rubeosis iridis

Treatment

Unilateral Retinoblastoma

- **Group A/ Stage IA** tumors can be treated by local therapy like Cryotherapy, laser photocoagulation, thermotherapy
- **Group B/ Stage IIA/ IIIA** – can be treated by Chemotherapy alone (Carboplatin and Etoposide) or single agent chemotherapy along with plaque radiotherapy

Radiotherapy may increase the risk of radiation-induced secondary malignancies

- **Group C/ Stage IB/IIB/IIIB** – triple chemotherapy with **C**arboplatin, **E**toposide and **V**incristine over six cycles
- **Group D** – Chemotherapy or Enucleation (preferred)
- **Group E** – Enucleation, i.e. removal of the whole eyeball along with the optic nerve (minimum stump of 10 mm)

Bilateral Retinoblastoma

- Group A/B/C symmetrical involvement – follow the same strategies as listed above
- Group D symmetrical involvement – 6 cycles of 3 drug chemotherapy with 3 cycles of local subtenon carboplatin (20 mg in 2 mL), followed by consolidation with laser
- Asymmetrical involvement with worse eye having Group E disease – Enucleation is recommended
- Asymmetrical involvement with worse eye giving Group D presentation – Chemotherapy or Enucleation

EXTRA MILE

Persistent Hyperplastic Primary Vitreous (PHPV) –

- Presents with unilateral **leukocoria** due to a retrolental mass, visual prognosis poor.
- Posterior subcapsular **cataract** is also seen to occur frequently.
- It **never presents with foci of calcification**, which helps to differentiate it from retinoblastoma.
- It is associated with Patau syndrome.
- Diagnostic features – microphthalmos and elongated ciliary processes
- May lead to tractional retinal detachment

Vitreoretinal Dysplasia – caused by faulty differentiation of retina and choroid presenting with leukocoria. It may be associated with

- Norrie disease – XLR
- Incontinentia pigmenti – XLD – mutations in NEMO gene
- Walker-Warburg syndrome – AR

LAST MINUTE REVISION – ONE LINERS

- Diameter of optic disc is 1.5mm. It is also known as the blind spot.
- Macula is situated 2DD/3mm/15^{O} temporal to the optic disc.
- Bipolar cells form the first order neurons and ganglion cells/optic nerve form the second order neuron of the visual pathway.
- IPM is an attachment between NSR and RPE containing IRBP, SPARC, matrix metalloproteinases.
- Direct ophthalmoscopy provides 15 times magnification, with a central 2DD view of fundus and a virtual and erect image formation.
- Indirect ophthalmoscopy provides 5 times magnification, with a peripheral 8DD view of fundus and a real and inverted image formation, formed with a +20D convex lens.
- ERG is an Action potential whereas EOG is a Standing potential.
- Multifocal ERG tests for responses from cones only.
- ERG – a-wave from Photoreceptors, b-wave from Muller cells and C-wave from RPE.
- Arden ratio is a measure of EOG with a normal value of >1.85.
- EOG is the IOC for Best's Macular dystrophy where ERG is normal and EOG is abnormal with a value of <1.50.
- DR – earliest sign is Microaneurysms, earliest pathologic change is Loss of pericytes.
- NPDR doesnot have neovascularization and has no treatment.
- PDR presents with neovascularization and is treated by PRP – done with Argon green laser.
- Diabetic macular edema/CSME is the most common cause of loss of vision and is treated with Focal laser photocoagulation.
- Keith-Wagner-Barker classification is for hypertensive retinopathy with vessel signs – Salus, Bonnet, Gunn, copper wiring, silver wiring.
- Macular star is seen in malignant hypertension and also in Neuroretinitis.
- Tomato ketchup appearance – Ischemic CRVO.
- Cattle tracking/ Box-Carring – CRAO.
- ROP should be screened in preterm infants born <34 weeks of age or <1750 gms.
- Amsler grid testing is done for detecting macular disorders.
- Smoke stack/ Ink blot/ Mushroom/ Umbrella appearance on FFA – CSR.
- Flower petal/Petalloid appearance on FFA – CME.
- CSR is due to abnormality in RPE whereas CME has abnormality in OPL.
- PDT uses Verteporfin drug.
- Choroidal neovascularization is the hallmark of Wet ARMD and is treated with Anti-VEGF drugs.
- Drusen are eosinophilic deposits and are seen in Dry ARMD – Vitamin A is n not advised as prophylaxis in Antioxidant therapy.
- Rod cells are seen most commonly in the perifoveal area and Cone cells at the Fovea.
- Retinitis pigmentosa is most commonly AR, presents with nyctalopia, tubular vision, bone spicule pigmentation and has an approved treatment in the form of Retinal Prosthesis.
- Best's macular dystrophy presents with Vitelliform lesions and a Pseudohypopyon.
- Rhegmatogenous RD occurs due to break and traction, tractional RD has no break only traction and exudative RD has no break and no traction.
- Most common cause of rhegmatogenous RD is pathological myopia.
- Most common cause of tractional RD is Diabetic retinopathy.
- Floaters are due to vitreal pathology and can be seen only in Rhegmatogenous RD.
- Shifting fluid is the hallmark of exudative RD.
- SF_6 and C_3F_8 can be used to tamponade and reattach a retina.
- Most common tumor to be associated with retinoblastoma is Pinealoblastoma and most common secondary malignant neoplasm associated is Osteosarcoma.
- Most common route of spread is Direct through the optic nerve.
- 90% cases are sporadic, and only 7-10% cases have familial history.
- TOC is Enucleation for Retinoblastoma
- Retinoblastoma is the most common cause of intraocular calcification.
- PHPV doesn't present with calcification, and is associated with microphthalmos.

BONUS PAGE 6

VITREOUS

Anatomy

It is an avascular, transparent gel composed of collagen, **hyaluronic acid**, water and occupies 80% of the total volume of the eye (4 mL). The anterior bounding surface of the vitreous body is known as the anterior hyaloid membrane.

Vitreous is firmly **attached** to the surrounding structures (the strongest to the weakest)

- **Vitreous base** (4 mm wide zone attached to the ora serrata, pars plana anteriorly and the peripheral retina posteriorly) – **the strongest attachment**
- Posterior lens capsule – by the hyaloideocapsular **ligament of Weigert**
- Margins of the optic disc
- At the macula
- Along the retinal vessels – the **weakest** attachment

Cloquet Canal

The central vitreous is traversed by a canal which is known as cloquet/hyaloid canal/retrolental tract.

It extends from the posterior surface of the lens to the optic nerve head[Q]. It represents the remnants of the **course of hyaloid artery during embryogenesis**. It is 1 to 2 mm in diameter and "S" shaped.

Vitreous Hemorrhage

VH leads to sudden, painless loss of vision and floaters associated with

- Diabetic retinopathy – **most common** cause of **spontaneous** VH
- Retinal break
- Posterior vitreous detachment (PVD)
- Rhegmatogenous retinal detachment
- Retinal neovascularization following RVO
- Trauma – **most common** cause in a **young male**, <40 years of age

Mechanisms

- **Rupture of abnormal vessels** – Neovascularization of the retina – in Diabetic retinopathy[Q], RVO, Sickle cell retinopathy and all other ischemic vascular diseases
- **Rupture of normal retinal vessels** – in PVD, RD, Retinal tear, Trauma, Terson's syndrome
- **Blood from adjacent source** – in ARMD

Asteroid Hyalosis

Calcium pyrophosphate globules hydroxyapatite crystals within the vitreous gel.
Move with the vitreous during eye movements but do not sediment inferiorly.

Synchisis Scintillans/Cholestrolosis

Cholesterol crystals – numerous yellowish white, gold colored in the vitreous.
Tend to sediment inferiorly when the eye is immobile.

IMAGE-BASED QUESTIONS

There are multiple probable questions that can be asked on a single image.

Question numbers 1 to 4 are based on Image 1.

Image 1

1. **Which ophthalmological investigation is being performed on the patient**
   a. Retinoscopy
   b. Indirect ophthalmoscopy
   c. Direct ophthalmoscopy
   d. Oblique illumination test

2. **The instrument is used for**
   a. Examination of the optic disc
   b. Fundus Examination
   c. Corneal Examination
   d. Examination of the Angle of Anterior Chamber

3. **All of the following are true about the above instrument except**
   a. Image formed is virtual and erect
   b. Magnification of the image is 15 times
   c. The field of view is central 10 degree
   d. It is done from a distance of 100 cm.

4. **All of the following are true about above procedure, except**
   a. It can be done with the patient being in any position
   b. There is no stereopsis
   c. Can be used in cases of hazy ocular media
   d. The retinal periphery cannot be examined

Question numbers 5 to 8 are based on Image 2.

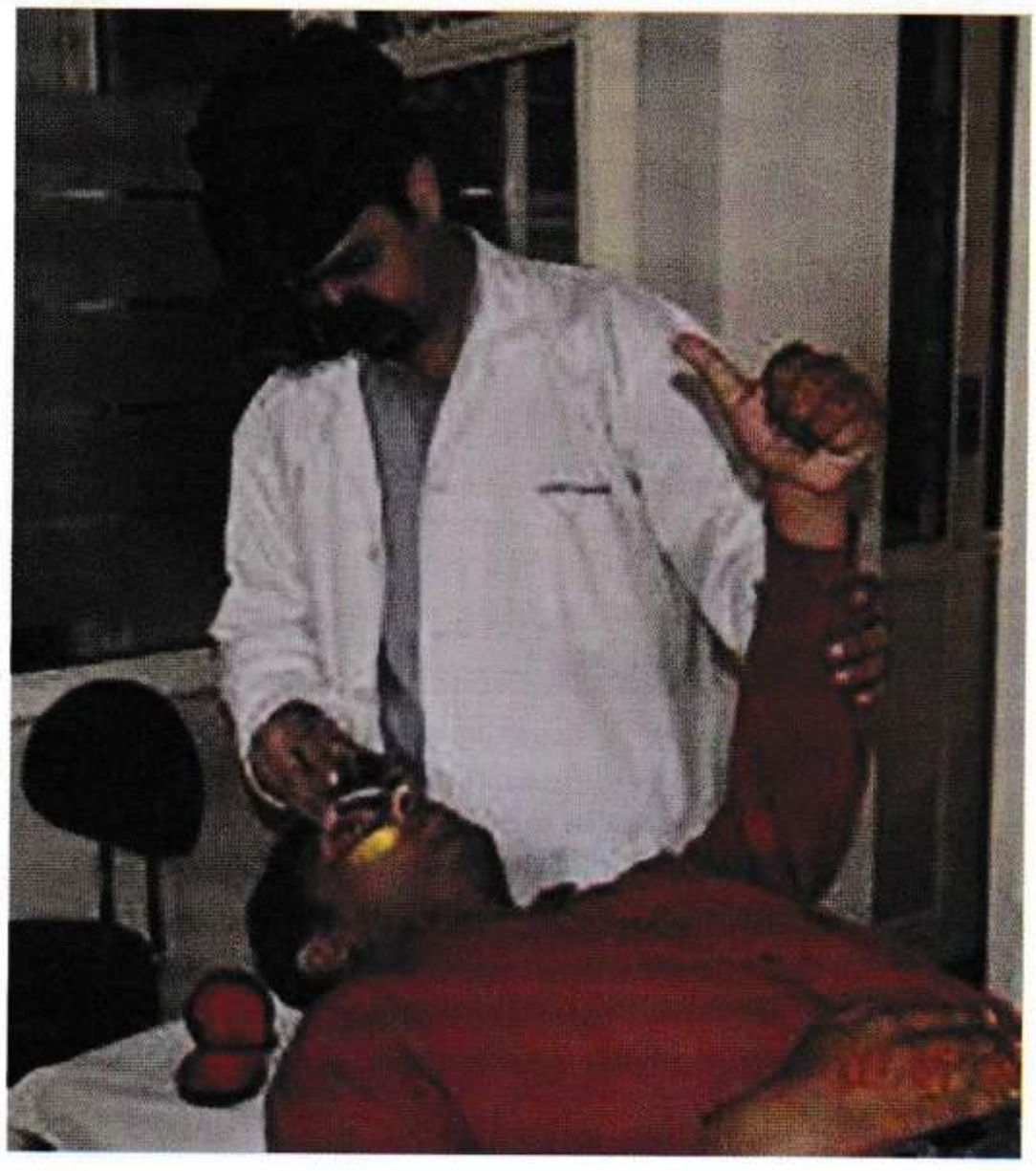


Image 2

5. **Which investigation is being performed in the patient?**
   a. Retinoscopy
   b. Indirect ophthalmoscopy
   c. Direct ophthalmoscopy
   d. Perimetry

6. **Which is not correct about the above instrument?**
   a. Convex lens is used
   b. Bright enough to visualize through hazy media
   c. Virtual and erect image
   d. 4-5 times magnification

7. **True about the field of observation of the instrument is**
   a. The size of the pupil affects the size of field of observation
   b. The field of view is directly proportional to the magnification
   c. The field of observation is always larger than the field of illumination
   d. The field of observation extends up to the Ora serrata

8. **All of the following are true except**
   a. It is a Binocular procedure
   b. The patient is examined in the sitting position
   c. The examiner stands opposite to the clock hour position to be examined
   d. It can be used to diagnose a case of Papilledema

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Question numbers 9 to 11 are based on Image 3.

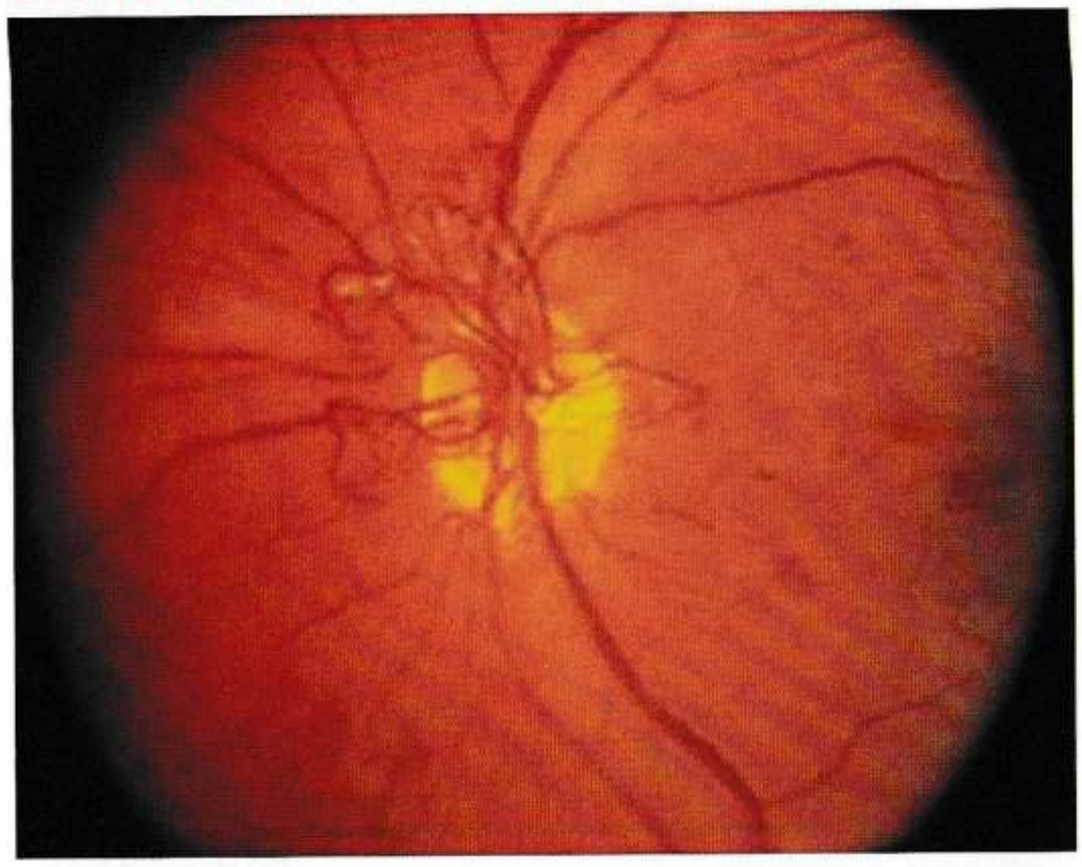

Image 3

9. Identify the sign seen in the above fundus photograph.

a. Neovascularization of the disc
b. Neovascularization elsewhere
c. Both of the above
d. None of the above

10. What is the most likely diagnosis for the above patient?

a. Non-proliferative diabetic retinopathy
b. Proliferative diabetic retinopathy
c. Central retinal vein occlusion
d. Hypertensive retinopathy

11. What is the most common cause of visual loss in the patient with the above photograph?

a. Macular edema
b. Vitreous hemorrhage
c. Retinal detachment
d. Neovascularization

Question numbers 12 and 13 are based on Image 4.

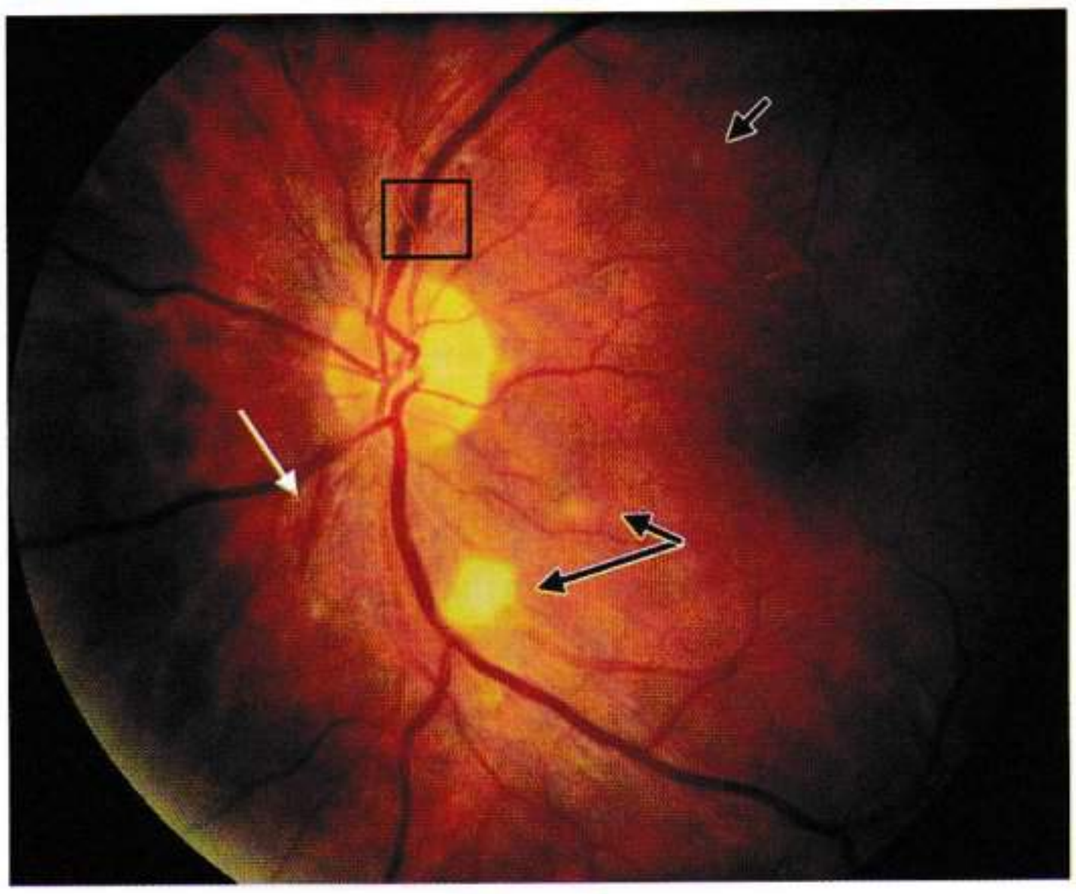

Image 4

12. All of the following signs can be seen in the above fundus photograph except

a. Hard exudates
b. Cotton wool spots
c. Flame shaped hemorrhages
d. Salus sign

13. What is the most likely diagnosis, in the above patient with complaints of gradual loss of vision?

a. Central retinal artery occlusion
b. Diabetic retinopathy
c. Hypertensive retinopathy
d. Central retinal vein occlusion

Question numbers 14 to 17 are based on Image 5.

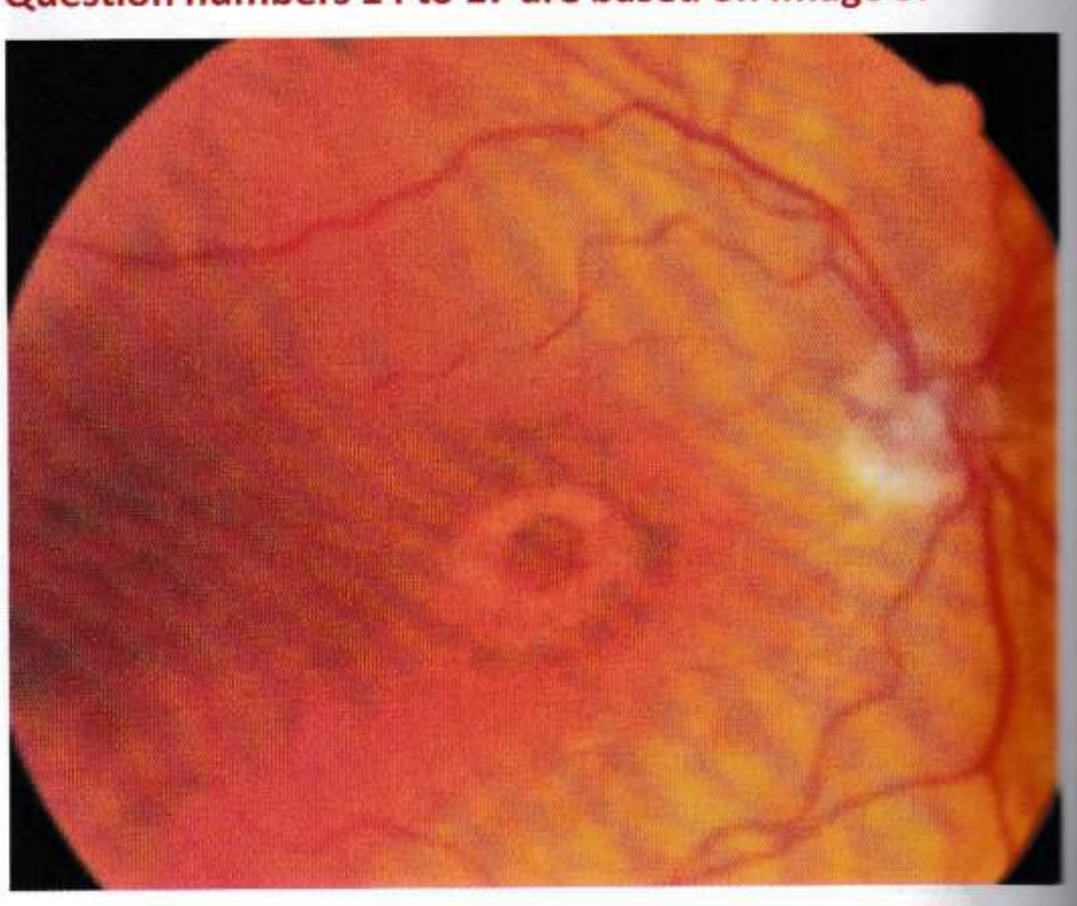

Image 5

14. The above fundus photograph is of the left eye of a patient who has a history of rheumatoid arthritis and is complaining of difficulty in reading. What is the most likely diagnosis?

a. Cherry red spot at macula
b. Bull's eye maculopathy
c. Macular hole
d. Central serous retinopathy

15. All of the following are causes of the fundus picture except

a. Cone dystrophy
b. Startgardt's disease
c. Stickler syndrome
d. Chloroquine maculopathy
e. Clofazimine retinopathy

16. All of the following are true for a patient with a history of chloroquine use and the above fundus picture except

a. Bull's eye maculopathy is reversible
b. Vortex keratopathy is not related to the dose
c. Duration of treatment >5 years is a risk factor for maculopathy
d. Develops with a cumulative dose >500 mg

17. Which of the following tests is inadequate during early screening in the above patient?

a. Multifocal ERG
b. Fluorescein angiography
c. OCT
d. Perimetry

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Question numbers 18 and 19 are based on Image 6.

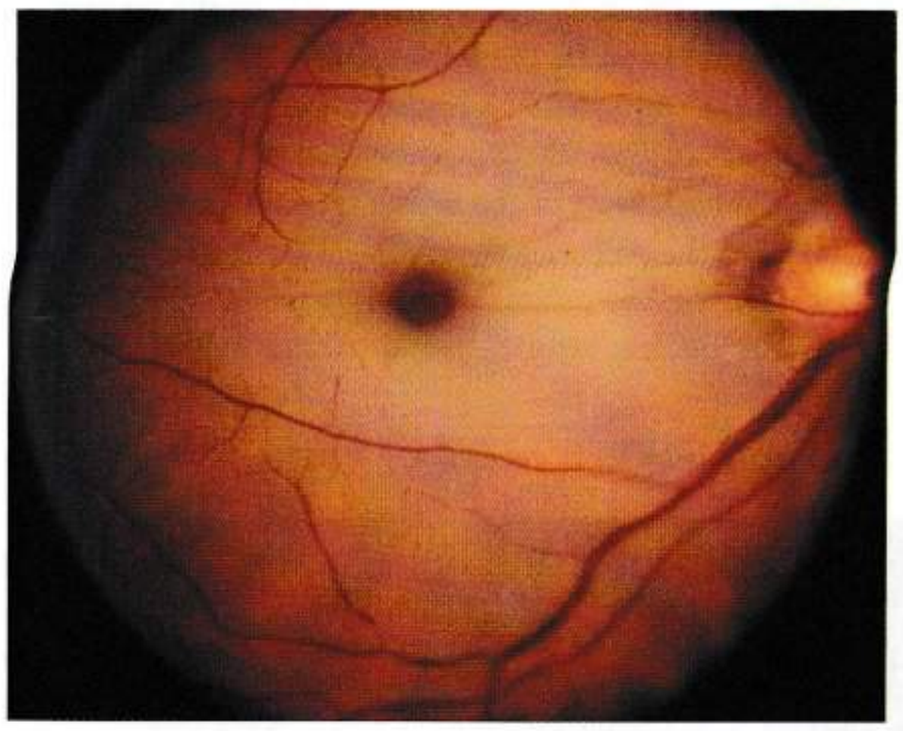

Image 6

18. **Parents bring in their 8 month old child presenting with neurodegeneration, developmental delay, hepatosplenomegaly and visual loss. On fundus examination the above (image) findings are seen. Which of the following diseases does the child most likely have?**
    a. Krabbe's Disease
    b. Niemann-Pick Disease Type
    c. Tay-Sachs Disease
    d. Gaucher's Disease
19. **A 72 year old woman is driven to the emergency department because 10 minutes earlier she had developed sudden, painless, unilateral blindness. When light is shone on the affected eye, the pupils fail to constrict. When light is shone on the opposite eye, both pupil constrict briskly. Tonometry of both eyes is within normal limits. On ophthalmoscopy, the above (image) is seen. Which of the following is the most likely diagnosis?**
    a. Age related macular degeneration
    b. Central retinal artery Occlusion
    c. Central Retinal vein occlusion
    d. Retinitis pigmentosa

Question numbers 20 and 21 are based on Image 7.

Image 7

20. **A 65-year-old white male presents with complaints of "seeing wavy lines when looking at the doorway or blinds" in his right eye. He feels that this occurred suddenly and has no pain or other ocular symptoms. His past medical history is significant for hypertension. He has a 40-pack-per year smoking history. On examination, his visual *acuity is 20/400 in the right eye. He has no RAPD and slit* lamp exam reveals that his anterior segment examination is normal. Examination of his left fundus reveals the findings in the above photograph. What is the most likely cause?**
    a. Wet age related macular degeneration
    b. Diabetic retinopathy
    c. Dry age related macular degeneration
    d. Hypertensive retinopathy
21. **What will be the best treatment for the above patient?**
    a. Laser photocoagulation
    b. Three monthly injections of Ranibizumab
    c. Photodynamic therapy
    d. Observation and follow-up

Question number 22 is based on Image 8.

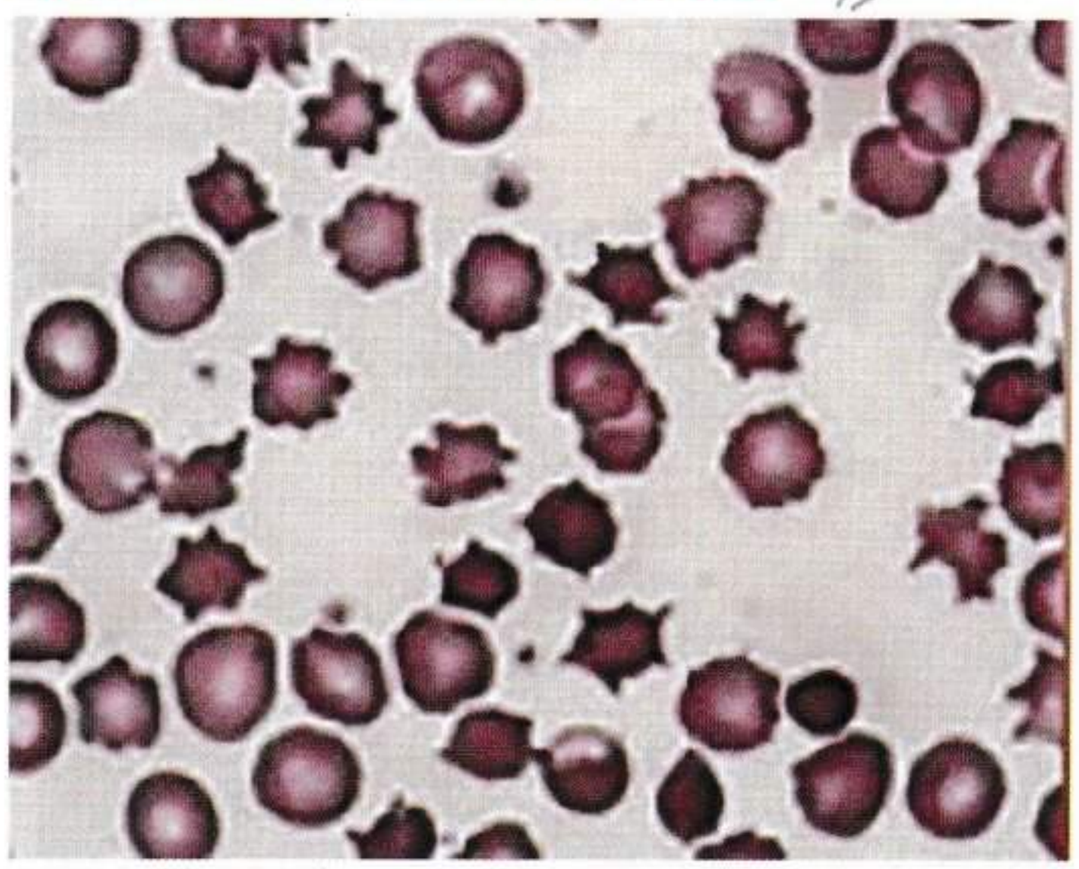

Image 8

22. **This the blood smear examination of a male aged 6 years. Which of the following ocular conditions is most likely to be associated in this patient?**
    a. Hypertensive retinopathy
    b. Sickle cell retinopathy
    c. Retinitis pigmentosa
    d. Purtschner retinopathy

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Question number 23 is based on Image 9.

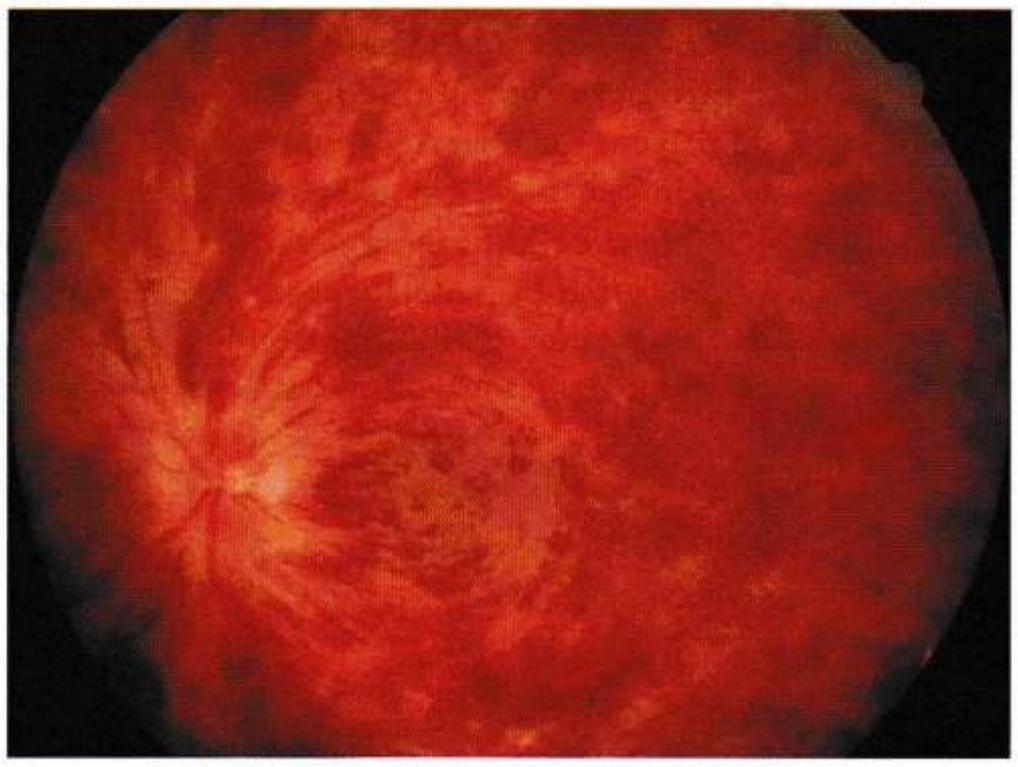

Image 9

23. **A male patient, 45 years of age with history of hypertension for past 8 years complaints of sudden loss of vision. Anterior segment examination is not contributory. On fundus examination the above is seen. What is the most likely diagnosis?** ***(Recent pattern Dec 2016)***

a. Ischemic CRVO
b. Hypertensive retinopathy
c. Diabetic retinopathy
d. CRAO

Question number 24 is based on Image 10.

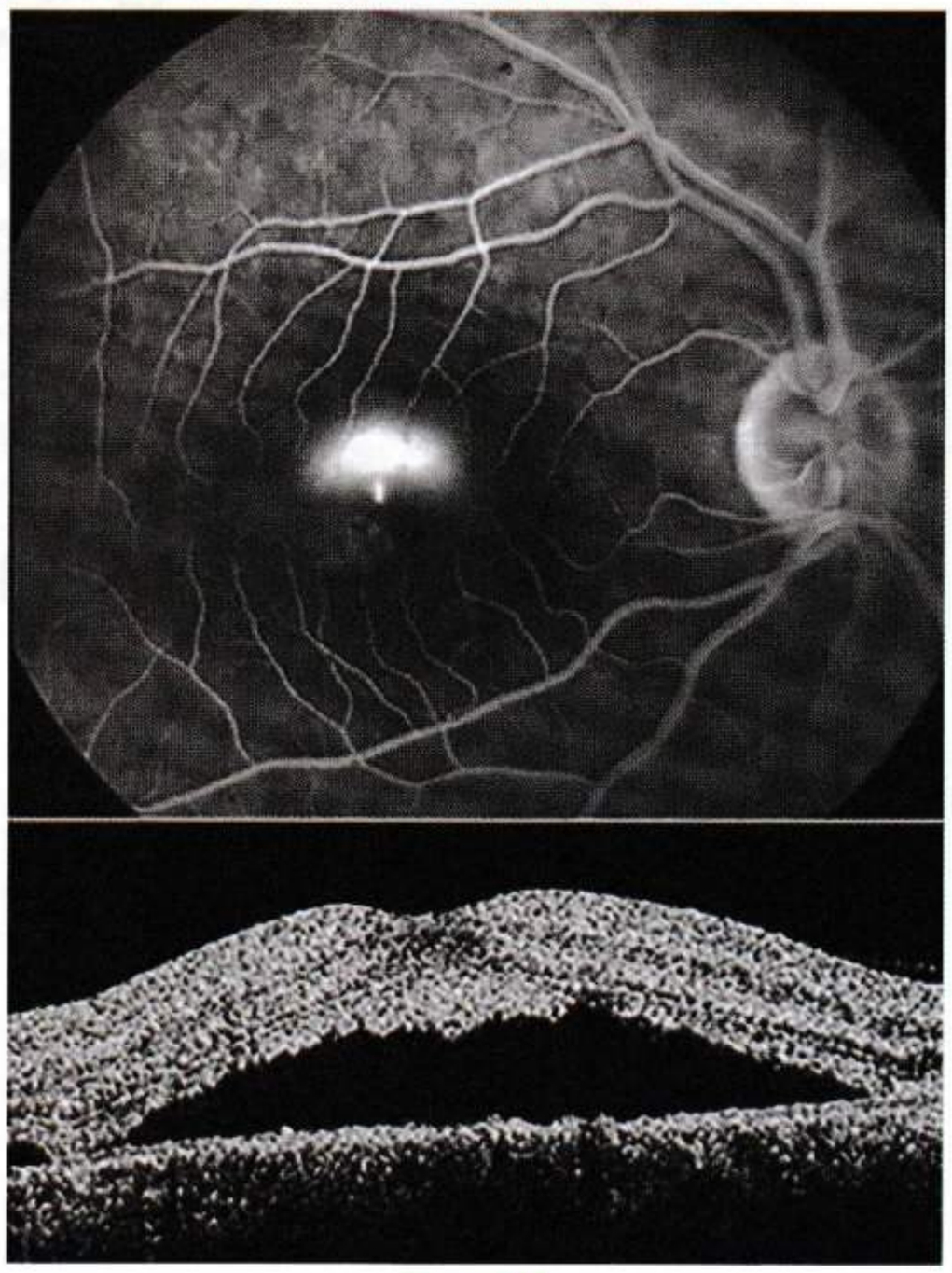

Image 10

24. **A young female came with complaints of diminished vision. On examination she had decreased vision is in the right eye (6/18) and normal vision in the left eye (6/6). The ophthalmologist did a fundus examination and ordered for a FFA. Above are the pictures of FFA and optical coherence tomography of the patient. Which layer of the retina is most likely involved to be involved in the pathology?** ***(AIIMS Nov 2016)***

a. Neurosensory retina
b. Retinal pigment epithelium
c. Outer nuclear layer
d. Inner nuclear layer

Question number 25 is based on Image 11.

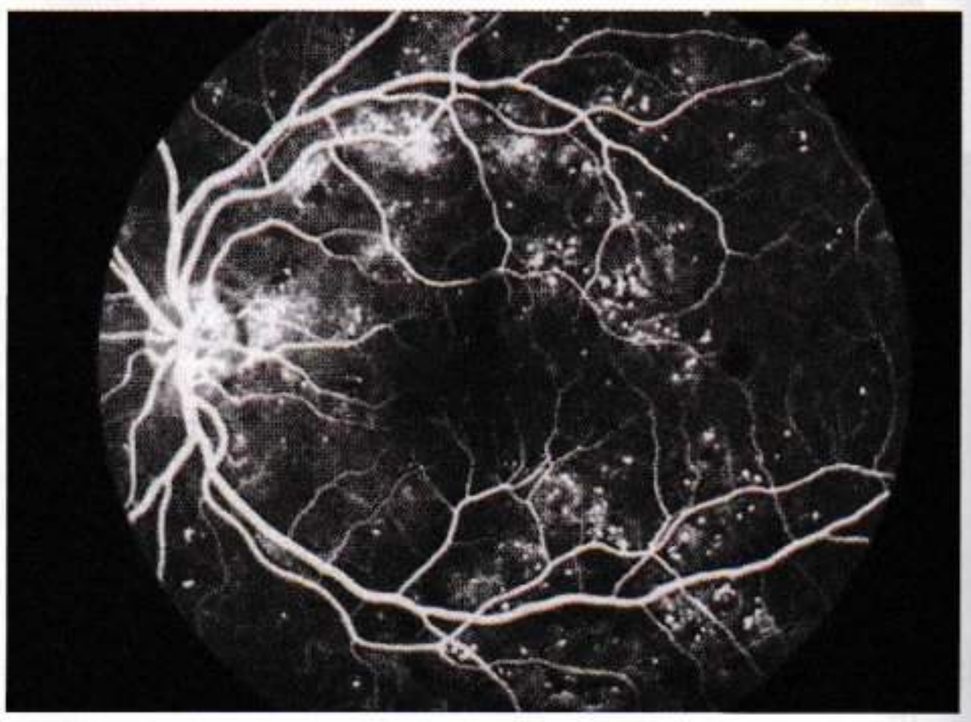

Image 11

25. **A 56 year old male, with history of diabetes for 15 years complaints of loss of vision. Diagnose the pathology based on the fundus fluorescein angiography shown in image 11?** ***(AIIMS Nov 2017)***

a. NPDR
b. PDR
c. Familial dominant drusen
d. Birdshot chorioretinopathy

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Question number 26 is based on Image 12.

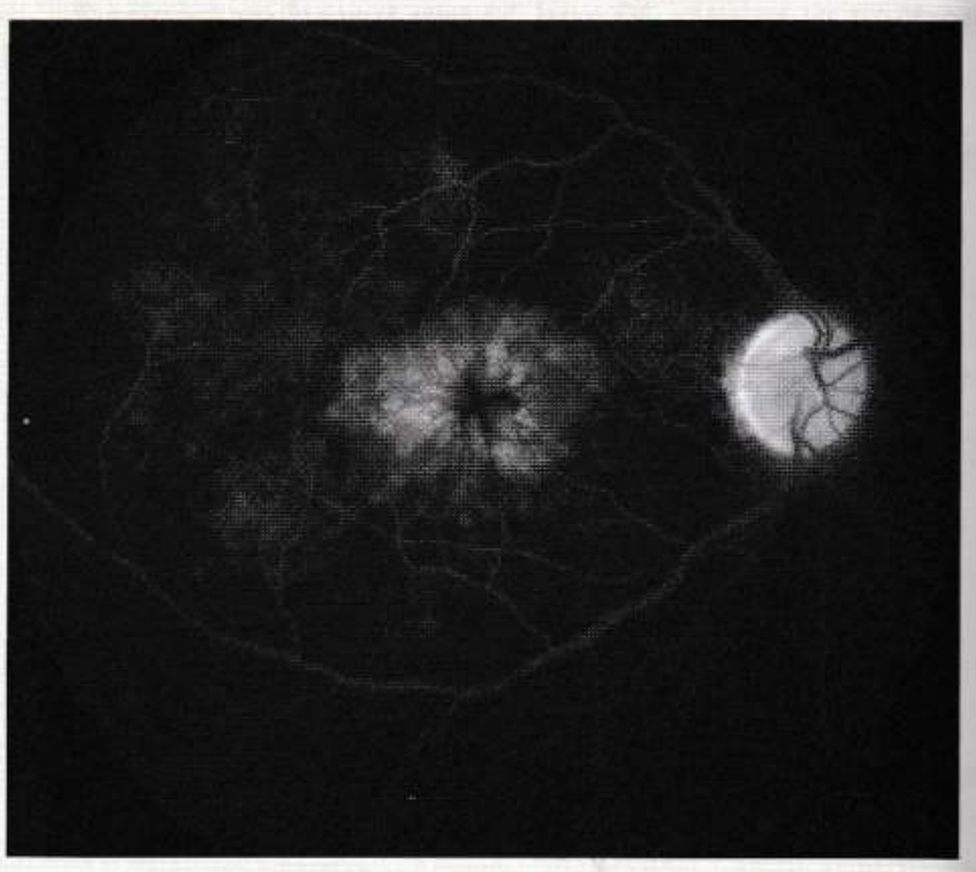

Image 12

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26. **50-year-old female with history of rheumatoid arthritis presented with gradual painless loss of vision over 3 years. She has history of cataract surgery in both eyes done 1 year back. Her fluorescein angiography result is given in image 12. What is the cause of her loss of vision?** ***(AIIMS May 2018)***

a. Chloroquine toxicity
b. Vancomycin toxicity
c. Cystoid macular edema
d. Choroiditis

Question number 27 is based on Image 13.

Image 13

27. **Fundus image of a 60 year old hypertensive and diabetic is given above. Which of the following is true about his condition?**

a. The above condition can form a part of hypertensive retinopathy only
b. The above condition can form a part of diabetic retinopathy only
c. It occurs due to acculmulation of proteins around the macula
d. Treatment is by Focal laser photocoagulation

Question number 28 is based on Image 14.

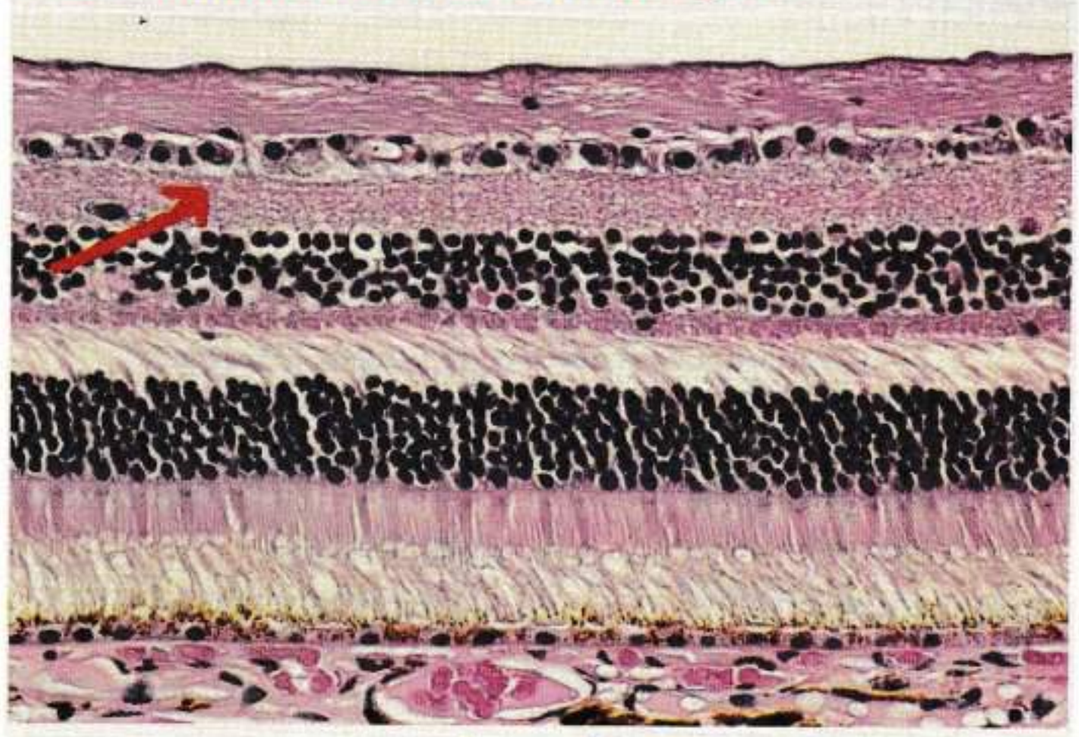

Image 14

28. **Identify the marked layer.** ***(AIIMS Nov 2018)***

a. Internal limiting membrane
b. Outer Plexiform layer
c. Inner plexiform layer
d. External limiting membrane

Question number 29 is based on Image 15.

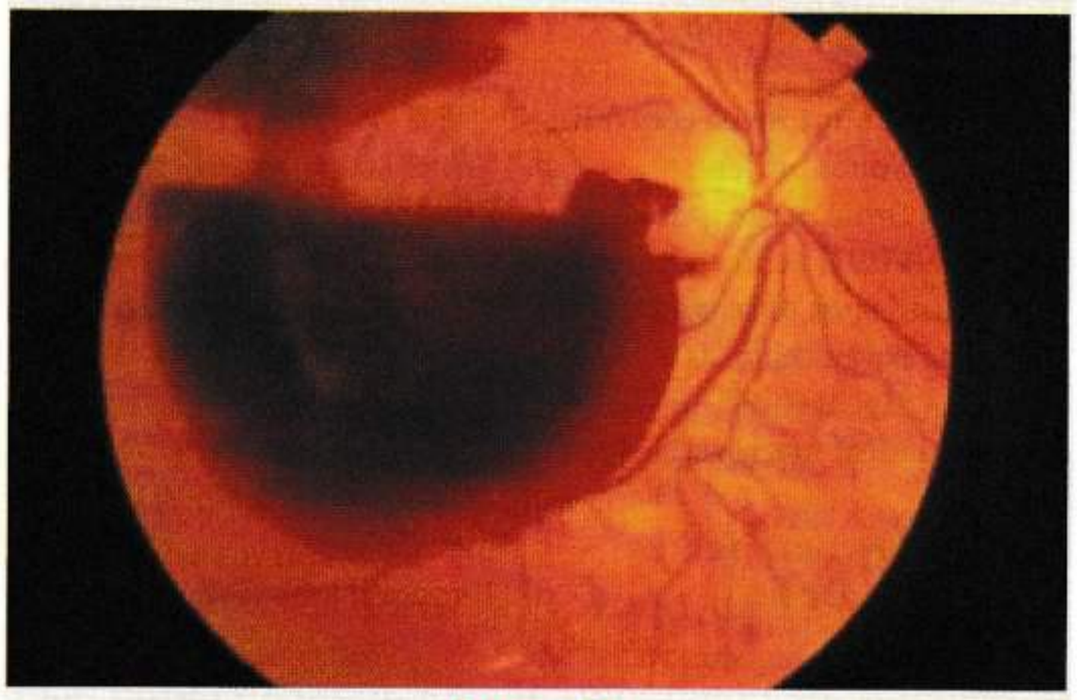

Image 15

29. **A 65 years old diabetic & hypertensive male presents with sudden loss of vision. His fundus image is shown below. What is the most likely diagnosis?**

a. Central serous retinopathy ***(Recent question June 2018)***
b. Central retinal artery occlusion
c. Vitreous haemorrhage
d. Rubeosis iridis

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MULTIPLE CHOICE QUESTIONS

Anatomy

30. Which of the following is not seen in the interphotoreceptor matrix.: *(All India 2008)*
a. Metalloproteinase
b. Sialoprotein associated with Rods and and Cones (SPARC)
c. Tissue inhibitors of Metalloproteinases (TIMP)
d. Memicane

31. The average distance of the fovea from the temporal margin of the optic disc is: *(All India 2006)*
a. 1 disc diameter
b. 2 disc diameter
c. 3 disc diameter
d. 4 disc diameter

32. The retina receives its blood supply from all, except: *(All India 2006)*
a. Posterior ciliary artery
b. Central retinal artery
c. Retinal arteries
d. Plexus of Zinn and Haller arteries

33. Area of Retina where only cones are concentrated *(NIMHANS 2016)*
a. Fovea
b. Macula
c. Optic nerve
d. Foveola

34. Most radioresistant cells in retina *(AIIMS Nov 2011)*
a. Retinal pigment epithelium
b. Ganglion cell layer
c. Rods and cones
d. Bipolar cells

35. True about fovea centralis: *(PGI May 2010)*
a. Cones present
b. Visual acuity lowest
c. Optic nerve passes
d. Rods present
e. Visual acuity highest

36. Blind spot of mariotte *(Recent pattern Dec 2013)*
a. Fovea centralis
b. Optic disc
c. Macula lutea
d. Ora serrata

37. Broadest neuroretinal rim is seen in *(Recent pattern Nov/Dec 2016)*
a. Superior pole
b. Inferior pole
c. Nasal pole
d. Temporal lobe

Clinical Examination

38. The magnification obtained with a direct ophthalmoscope is *(All India 2006)*
a. 5 times
b. 10 times
c. 15 times
d. 20 times

39. What is the indication of using indocyanine green angiography? *(Recent pattern Nov/Dec 2016)*
a. Occult choroidal neovascularisation
b. Conjunctivitis
c. Vitreous hemorrhage
d. Corneal ulcer

40. Which of the following is false about indirect ophthalmoscopy? *(AIIMS Nov 2014)*
a. Image is virtual and erect
b. It is so bright that haziness is penetrated
c. Magnification of is 4-5 times
d. Convex lens is used

41. True about electroretinogram: *(PGI Nov 2015)*
a. a wave- arises from rods and cones
b. b wave - d/t activity of bipolar cells
c. b-wave response is subnormal in early cases of retinitis pigmentosa
d. c wave - representing metabolic activity of pigment epithelium
e. Best disease shows abnormal ERG

42. Which of the following is the feature of sodium fluorescein angiography compared to indocyanine green angiography: *(PGI Nov 2016)*
a. In choroidal circulation it passes freely across the endothelium
b. Diffuse freely through retinal capillaries
c. Albumin binding is less than indocyanine green
d. Bind < 50% to albumin
e. Stimulated by a longer wavelength of light

43. Magnification obtained with direct ophthalmoscope for an emmetropic patient is: *(AIIMS May 2005, Recent pattern 2015)*
a. 5 times
b. 10 times
c. 15 times
d. 20 times

44. Investigation of choice of vitreous hemorrhage is
a. Ultrasound biomicroscopy *(Recent pattern Nov/Dec 2016)*
b. A-Scan
c. B-Scan USG
d. OCT

45. Arden index is related to *(Recent pattern July 2016)*
a. ERG (Electroretinogram)
b. EOG (Electroculogram)
c. VER (Visual evoked response)
d. Perimetry

46. Confirmatory investigation in retinitis pigmentosa is *(Recent pattern Nov/Dec 2016)*
a. Optical coherence tomography
b. Pachymetry
c. Visual acuity testing
d. Electroretinogram

47. Multifocal ERG is useful to assess the function of: *(AIIMS May 2015)*
a. Rods
b. Macular cones
c. Ganglion cells
d. Retinal pigment epithelium

48. True statements regarding Direct Ophthalmoscopy are all except: *(AIIMS May 2015)*
a. Image is virtual and erect
b. 2 disk diameter field of vision
c. Magnification is 5 times
d. Self-illuminated device

49. The normal ratio of light peak and dark trough on an EOG is *(AIIMS Nov 2014)*
a. 1
b. 1.5
c. More than 185%
d. Less than 185%

50. Distant direct ophthalmoscopy is done at
a. 100 cm
b. 25 cm
c. As close to the face as possible
d. 1 m

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51. **An 18 years old girl who was using spectacles for last 10 years, came with the history of photopsia and sudden loss of vision in right eye. Which one of the following clinical examinations should be performed to clinch the diagnosis?** ***(AIIMS Nov 2004)***
   a. Cycloplegic refraction b. Indirect ophthalmoscopy
   c. Schiotz tonometry d. Gonioscopy
52. **Fluorescein for ophthalmological diagnosis is injected in –** ***(Recent pattern 2015)***
   a. Antecubital vein b. Popliteal vein
   c. Femoral vein d. Subclavian vein
53. **A wave in ERG is due to activity of –** ***(Recent pattern 2012)***
   a. Pigmented epithelium b. Rods and Cones
   c. Ganglion Cell d. Bipolar Cell
54. **Amsler's grid is used to evaluate –** ***(Recent pattern Nov/Dec 2016)***
   a. Central 10 degrees of vision
   b. Central 20 degrees of vision
   c. Peripheral vision
   d. Lens Opacity

Vascular Disorders

55. **Acute loss of vision in case of alcoholic pancreatitis:**
   a. Purtscher's retinopathy ***(AIPG 2010)***
   b. Acute congestive glaucoma
   c. Central retinal artery obstruction
   d. Optic neuritis
56. **Purtscher retinopathy is seen in patients with** ***(Recent pattern Nov 2015)***
   a. Complication of chronic pancreatitis
   b. Occlusion of anterior retinal artery
   c. Head trauma
   d. Diabetes mellitus
57. **Angioid streaks in the eyes are seen in** ***(AIIMS Nov 2005)***
   a. Pseudoxanthoma elasticum
   b. Tendinous xanthoma
   c. Xanthelasma
   d. Eruptive xanthoma
58. **A case of Non-Insulin dependent diabetes mellitus (NIDDM) with a history of diabetes for one year should have an ophthalmic examination?** ***(All India 2006)***
   a. As early as feasible
   b. After 5 years
   c. After 10 years
   d. Only after visual symptoms develop
59. **A 45 year old man is diagnosed with diabetes at his present visit of the first time. When should he undergo an ophthalmoscopic examination by an ophthalmologist?**
   a. On his 50th birthday ***(AIIMS Nov 2014)***
   b. When vision begins to decrease
   c. Immediately
   d. After 3 years
60. **Microaneurysms are the earliest manifestation of diabetic retinopathy; they are most commonly found in which retinal layer** ***(AIIMS Nov 2014)***
   a. Layer of rods and cones
   b. Ganglion cell layers
   c. Outer plexiform layer
   d. Inner nuclear layer
61. **A 40 year old male with diabetes presents with vitreous hemorrhage. What is the cause?** ***(AIIMS May 2012)***
   a. Posterior retinal detachment
   b. Neovascularization at disc
   c. Central retinal vein occlusion
   d. Trauma to central retinal artery
62. **Treatment of Advanced Proliferative Diabetic Retinopathy with extensive vitreoretinal fibrosis and tractional retinal detachment involves all of the following except**
   a. Reattachment of detached or torn retina ***(All India 2009)***
   b. Removal of epiretinal membrane
   c. Vitrectomy
   d. Exophotocoagulation
63. **A patient with clinically significant diabetic macular edema with nonprogressive diabetic retinopathy was treated with Macular grid photocoagulation. The patient still have vitreo macular traction. What is the preferred treatment?**
   a. Intravitreal bevacizumab ***(AIIMS May 2011)***
   b. Pars plana vitrectomy
   c. Repeat macular grid photocoagulation
   d. Augmented macula photocoagulation
64. **Which of the following agents is not used in the treatment of Diabetic Macular Edema/Retinopathy:** ***(All India 2011)***
   a. Ruboxistaurim b. Pyridazinones
   c. Benfotiamine d. Tamoxifen
65. **False statement regarding diabetic retinopathy:**
   a. Flame shaped haemorrahges ***(PGI May 2012)***
   b. Arteriovenous nipping
   c. Neovascularisation
   d. Hard exudates
   e. Exudative macular edema
66. **Indications of Retinal laser photocoagulation are all except:** ***(PGI Nov 2011)***
   a. Proliferative DM b. Non-proliferative DM
   c. Macular edema d. Eales' disease
   e. Retinopathy of prematurity
67. **Causes of floaters in DM is:** ***(PGI May 2010)***
   a. Vitreous hemorrahage b. Vitreal detachment
   c. Maculopathy d. Infarction
68. **Features of non-proliferative DR is all except:** ***(PGI May 2010)***
   a. Neovascularisation b. Soft exudate
   c. Hard exudate d. Vitreous detachment
   e. Cotton-wool spot
69. **Cotton wool spot is/are seen in:** ***(PGI May 2010)***
   a. Diabetic retinopathy
   b. Hypertensive retinopathy
   c. AIDS
   d. Retinoblastoma
   e. Toxaemia of pregnancy
70. **Dot and blot hemorrhages and flame shaped hemorrhages can be seen characateristically in which of the following conditions** ***(Recent pattern 2016)***
   a. Hypertensive retinopathy
   b. Diabetic retinopathy
   c. Retinitis pigmentosa
   d. Central retinal artery occlusion

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71. In diabetic retinopathy pan retinal photocoagulation is done by *(Recent pattern Dec 2015)*

a. Argon green
b. Nd: YAG
c. Holmium
d. Transpupillary thermotherapy

72. A 42 year old woman was recently diagnosed with type 2 diabetes mellitus. Which statement is most correct?

a. Immediate focal laser photocoagulation should be performed if her vision is 6/6 and she has clinically significant macular edema.
b. According to the DCCT, tight control of patient's blood sugar would decrease her risk of developing diabetic retinopathy.
c. Immediate scatter photocoagulation should be applied if neovascularization of the disc and vitreous hemorrhage are present.
d. Focal laser photocoagulation should be performed if fluorescein leakage is present in the centre of fovea, even if the clinical examination does not show retinal thickening.

73. All of the following statements are false except

a. Very severe NPDR has a 45% chance of progression to high risk PDR within 1 year
b. Argon laser photocoagulation is contraindicated in cases of Ischemic Maculopathy (DME) if Foveal Avascular zone <1000 microns
c. Panretinal Photocoagulation for PDR should be done in a single sitting as it can lead to visual field defects
d. Aspirin at a dose of 650mg/day slowed the progression of retinopathy

74. True regarding cotton wool spots, all except

a. Result from arteriolar occlusion in the nerve fiber layer
b. Tend to persist for a shorter duration in hypertensive retinopathy as compared to diabetic
c. Are usually greater than 1 disc diameter in size
d. Result from interruption of axoplasmic flow

75. All of the following take part in the pathogenesis of macular edema in diabetic retinopathy except *(AIIMS May 2008)*

a. Retinal pigment epithelium dysfunction
b. Oxidative stress
c. VEGF
d. Increased protein kinase-C

76. First retinal abnormality in diabetic retinopathy *(PGI June 2009, 2000, Dec 2007, AIIMS 1991, Punjab 2011)*

a. Microaneurysm
b. Hard exudates
c. Soft exudates
d. Cotton wool spots

77. Diabetic ischemic maculopathy is characterized by all except *(Recent pattern Dec 2015)*

a. It occurs due to microvascular blockage
b. Mild visual loss
c. Areas of non-perfusion are evident on fluorescein angiography
d. Microaneurysms and hemorrhages are seen

78. Panretinal photocoagulation is indicated in

a. Macular edema *(Recent pattern 2014)*
b. Retinal breaks
c. Proliferative diabetic retinopathy
d. Tractional retinal detachment

79. All of the following may be used to differentiate Central Retinal Venous Occlusion (CRVO) from Ocular Ischemic Syndrome due to Carotid Artery Stenosis, Except *(All India 2009)*

a. Dilated retinal vein
b. Tortuous retinal vein
c. Retinal artery pressure
d. Ophthalmodynamometry

80. A 55 year old diabetic patient presents with unilateral transient obscuration for 2-3 days followed by sudden diminution of vision. Which of the following tests would you order? *(AIIMS May 2013)*

a. Serum homocsyteine level
b. Serum creatinine level
c. Serum ACE levels
d. Quantiferon Gold TB test

81. Features of ocular ischemic syndrome includes all except: *(PGI May 2015)*

a. Microaneurysm
b. Dot & blot haemorrhage
c. More common in elderly women than men
d. Disc edema
e. Amaurosis fugax

82. Tomato ketchup retina is seen in *(Recent pattern July 2016)*

a. Central retinal artery occlusion
b. Central retinal vein occlusion
c. Coats disease
d. Sickle cell retinopathy

83. Which of the following statements are correct? *(PGI style)*

a. Rubeosis iridis occurs earlier in CRVO than CRAO
b. Ischemic CRVO is associated with Splash Tomato appearance of the fundus
c. On Fluorescein Angiography, >10 disc areas of nonperfusion are associated with an increased risk of neovascularization
d. Inversion of the b wave to a wave amplitude ratio on ERG
e. Prophylactic PRP should be done in patients with Ischemic CRVO

84. A 30 year old patient with history of recurrent headache was sent for fundus evaluation. He was found to be having generalized artenial attenuation with multiple cotton wool spots and flame shaped haemorrhages in both eyes. The most likely cause is – *(AIIMS Nov 2005)*

a. Diabetic retinopathy
b. Hypertensive retinopathy
c. Central retinal artery occlusion
d. Temporal arteritis

85. All of the following are true with regard to malignant hypertension except

a. Papilledema is seen
b. Can cause sudden loss of vision
c. Elschnig spots are seen
d. Tractional retinal detachment can be seen

86. Which of the following is seen in chronic hypertensive retinopathy *(Recent pattern Dec 2013)*

a. AV nicking
b. Microaneurysm
c. Tortuous arteries
d. Exaggerated light reflex

87. Cherry red spot is seen in all except

a. Niemann pick disease
b. GM1 Gangliosidosis
c. Tay Sach's disease
d. Gaucher's disease

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88. **Cherry red spot and Hollenhorst plaque are seen in** *(AIIMS May 2015)*
a. CRAO b. CRVO
c. Branch RAO d. Branch RVO

89. **Cherry red spot is seen in all of the following conditions except** *(All India 2007)*
a. GM1 gangliosidosis
b. Niemann pick disease
c. Krabbe's disease
d. Multiple sulfatase deficiency

90. **Central Retinal artery occlusion is known to be associated with:** *(All India 2012)*
a. Panophthalmitis
b. Diabetic Retinopathy
c. CMV retinitis
d. Orbital mucomycosis

91. **Trucking of vessels is seen in which of the following disorders**
a. Central retinal artery occlusion *(Recent pattern 2015)*
b. Central retinal vein occlusion
c. Hypertensive retinopathy
d. Sickle cell retinopathy

92. **A 56 year old woman came to the emergency room 3 hours after visual loss in the right eye. Visual sensitivity limits to light perception in the right eye. Examination reveals pupillary defect whereas anterior surface of both eye are normal. Fundus examination shows a red lesion with pale retina. Probable diagnosis.** *(JIPMER May 2016)*
a. Central vein occlusion
b. Proliferative diabetic retinopathy
c. Background diabetic retinopathy
d. Central retinal artery occlusion

93. **Cattle track appearance** *(Recent pattern 2012)*
a. CRVO b. CRAO
c. Diabetic retinopathy d. Syphilitic retinopathy

94. **All of the following statements are true about juxtafoveal Retinal Telengiectasias, Except** *(All India 2009)*
a. Variant of Coat's disease
b. Associated with telengiectasias in the macula
c. Associated with structurally abnormal retinal vessels
d. Associated with peripheral telengiectasias

95. **A 7 year old presents with left exotropia; right eye has 6/6 vision with normal fundus. Left eye has only close hand movements with subretinal yellow exudates and retinal detachment and telegiectatic vessels. Diagnosis is:**
a. Sympathetic ophthalmia *(AIIMS Nov 2014)*
b. Coats disease
c. ROP
d. Familial exudative vitreous retinopathy (FEVR)

96. **Exudates are seen in which layer of retina** *(AIIMS Nov 2014)*
a. Outer plexiform layer b. Inner nuclear layer
c. Ganglion cells layer d. Rod & Cones layer

97. **An infant weighing less than 1000 gm is more likely to develop which of the following complications?**
a. Cataract *(AIIMS May 2013)*
b. Retinopathy of prematurity
c. Retinal detachment
d. Glaucoma

98. **Baby born prematurely at 29 wks on examination at 42 wks with ROP both eyes shows stage 2 zone 1 'plus' disease, how will u manage the patient?** *(AIIMS May 2011)*
a. Examine the patient after 1 week
b. Laser photocoagulation of both eyes
c. Laser photocoagulation of worse eye, follow-up of other eye
d. Vitreoretinal surgery

99. **True about Retinopathy of prematurity:** *(PGI May 2012)*
a. Resolves spontaneously in majority of cases
b. Laser or cryotherapy is used in treatment
c. No treatment required in majority of infant
d. Seen in full term infants with high flow of oxygen
e. Hyperbaric oxygen is given for treatment

100. **Coat's disease** *(Manipal 2009)*
a. Has equal sex incidence
b. Caused by peripheral neovascularization
c. Is inherited in an autosomal dominant pattern
d. Can be treated with laser

101. **What is the treatment of threshold ROP?** *(AIIMS Nov 2010)*
a. Laser photocoagulation b. Slow reduction in oxygen
c. Retinal reattachment d. Antioxidants

102. **'Sea-fan' neovascularization is seen in**
a. Diabetic retinopathy b. Purtscher's retinopathy
c. Sickle cell retinopathy d. Valsalva retinopathy

Macular Disorders

103. **Indocyanine Green Angiography (ICG Angiography) is most useful in detecting** *(All India 2009)*
a. Occult Choroidal Neovascularization (Occult CNV)
b. Classic Choroidal Neovascularization (Classic CNV)
c. Angioid streaks with Choroidal Neovascularization (CNV)
d. Polypoidal Choroidal Vasculopathy

104. **A young male presents with central scotoma in left eye. His right vision showed 6/6 vision. On examination, in the left eye, there was focal foveal detachment. What should be the next step?** *(AIIMS Nov 2014)*
a. Laser photocoagulation
b. Ask for history of trauma
c. Enquire about the use of steroids
d. Examine retrolental cells

105. **A 70-year-old man presents with deterioration of vision 3 weeks after cataract extraction and IOL implantation. Slit lamp examination shows honeycomb maculopathy and Fluorescein angiography (FA) show 'flower petal' hyperfluorescence. The most likely diagnosis:** *(All India 2012)*
a. Age related macular degeneration (ARMD)
b. Central serous retinopathy (CSR)
c. Macular dystrophy
d. Cystoid macular edema

106. **Risk factor for cystoid macular edema include (s) all except:** *(PGI Nov 2015)*
a. Hypertensive retinopathy
b. Vitreous loss
c. Diabetes mellitus
d. Cataract surgery
e. Lower incidence with intracapsular cataract extraction than extracapsular cataract extraction

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107. All are true about treatment of Age related macular degeneration except: *(PGI May 2014)*

a. Intravitreal anti-VEGF therapy
b. Laser abalation
c. Photodynamic therapy (PDT)
d. Transpupillary thermotherapy
e. Prognosis after treatment for non-exudative variety is very good

108. True about Central serous retinopathy: *(PGI Nov 2012)*

a. May recur in same or opposite eye
b. Smoke-stack pattern on FFA
c. Self-limited
d. Treatment is required in minority of the cases
e. Due to defect in photoreceptors

109. Which of the following group of drugs can cause Cystoid macular edema? *(Recent pattern 2015)*

a. Prostaglandin F2α analogues
b. Prostaglandin E2 analogues
c. Oral corticosteroids
d. α blockers

110. Which of the following should not be given in the prophlylaxis of Dry ARMD?

a. Vitamin A
b. Vitamin C
c. Vitamin E
d. Lutein

111. A 25 year old executive presents with metamorphopsia in his right eye. On examination the fundus shows a shallow detachment at the macula. The fluorescein angiography shows a "smoke stack" sign. Which of the following management should be given? *(AIIMS Nov 2003)*

a. Topical antibiotic-corticosteroid combination
b. Systemic corticosteroid for two weeks and then taper
c. Pulse methyl Prednisolone for three days and then taper
d. Just wait and watch for spontaneous recovery

112. Umbrella configuration on fluorescein angiography is seen in- *(Recent pattern Dec 2013)*

a. Retinitis pigmentosa
b. Rhegmatogenous retinal detachment
c. Central serous retinopathy
d. Eale's disease

113. Enlarging dot sign in fundus fluorescein scanning is seen in

a. Cystoid macular edema *(Recent pattern Dec 2014)*
b. Central serous retinopathy
c. Significant macular edema
d. Coat's disease

114. A 70-year-old man presents with deterioration of vision 3 weeks after cataract extraction and IOL implantation. Slit lamp examination shows honeycomb maculopathy and Fluorescin angiography (FA) shows 'flower petal' hyperfluorescence. The most likely diagnosis is *(AI 2012)*

a. Age related macular degeneration (ARMD)
b. Central serous retinopathy (CSR)
c. Macular Dystrophy
d. Cystoid macular edema

Fundus Dystrophies

115. Which of the following conditions has autosomal dominant inheritance: *(All India 2007)*

a. Gyrate atrophy
b. Best Disease
c. Lawrance Mood Biedl Syndrome
d. Bassen Kornzweig's Disease

116. Mizuo phenomenon is seen in *(All India 2010, AIIMS Nov 2011)*

a. Fundus albipunctatus b. Oguchi's disease
c. Fundus flavimaculatus d. Choroidermia

117. A yourg adult presents with night blindness and tubular vision. On examination, Intraocular Pressure was observed to be 18 mm and the anterior segment was unremarkable. Fundoscopy showed attenuation of arterioles and waxy pallor of the optic disc with bony corpuscles like spicules of pigmentation in mid peripheral retina. Ring scotomas were observed on perimetry. Which of the following is the most likely diagnosis: *(All India 2012)*

a. Pigmentary retinal dystrophy
b. Primary open angle glaucoma
c. Lattice degeneration of retina
d. Diabetic retinopathy

118. A young patient presents to the ophthalmology clinic with loss of central vision. There is no obvious family history. ERG and EOG were observed to be normal which of the following is the most likely diagnosis. *(All India 2011)*

a. Stargardt's disease
b. Best's Vitelliform Dystrophy
c. Retinitis pigmentosa
d. Cone-Rod Dystrophy

119. A young patient presents to the ophthalmology clinic with loss of central vision. ERG is normal but EOG is abnormal. Which of the following is the most likely diagnosis. *(All India 2011)*

a. Stargardt's disease b. Best's Vtielliform dystrophy
c. Retinitis pigmentosa d. Cone-Rod dystrophy

120. Doughnut scotoma is seen in which of the following conditions? *(Recent pattern 2016)*

a. Blue dot cataract b. Diabetic retinopathy
c. Nuclear cataract d. Retinitis pigmentosa

121. Retinitis pigmentosa is associated with all except

a. Usher syndrome *(AIIMS May 2008)*
b. Marfan's syndrome
c. Kearns-Sayre syndrome
d. Bassen-Kornzweig syndrome

122. Retinitis pigmentosa is a feature of all except *(AIIMS Nov 2010)*

a. Refsum's disease b. Hallervorden-Spatz disease
c. NARP d. Abetalipoproteinemia

123. Retinitis pigmentosa is due to defect in which gene *(NEET pattern Dec 2012)*

a. Scotopsin b. Rhodopsin
c. Pigmented epithelium d. None

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124. **The most frequent cataract type seen in adult retinitis pigmentosa patient is** *(Recent pattern 2015)*
   a. PSC
   b. Anterior polar
   c. Cortical
   d. Mixed

125. **Idiopathic nyctalopia is due to a hereditary** *(AIIMS Nov 2005)*
   a. Absence of rod function
   b. Absence of cone function
   c. Absence of rod and cone function
   d. Decrease of cone function

Retinal Detachment

126. **Which layer seperates in retinal detachment?** *(Recent pattern 2013)*
   a. Sensory retina
   b. Pigmentary retina
   c. Inner nuclear layer
   d. Outer plexiform layer

127. **In retinal detachment** *(NEET Dec 2012 pattern, Recent pattern 2013)*
   a. Effusion of fluid into the suprachoroidal space
   b. Retinoschisis
   c. Separation of sensory retina from pigment epithelium
   d. None of the above

128. **Retinal tears seen most commonly seen in** *(Recent pattern Dec 2015)*
   a. Primary retinal detachment
   b. Secondary retinal detachment
   c. Tractional retinal detachment
   d. Exudative retinal detachment

129. **Pneumoretinopexy is an outpatient procedure in which retinal detachment is sealed with air insufflation. Which of the following gas is used in pneumoretinopexy** *(AIIMS Nov 2014)*
   a. Nitrous oxide
   b. Sulfur hexafluoride (SF6)
   c. Perfluoroethane (C2F4)
   d. Perfluoropropane (C_3F_6)

130. **The risk of rhegmatogenous retinal detachment is increased in all of the following except:** *(AIIMS May 2013)*
   a. Hyperopia
   b. Pseudophakia
   c. Lattice degeneration
   d. Trauma

131. **A patient presents with flashing light, sudden floaters and perception of a curtain falling in front of the eye. Which of the following is the most likely diagnosis:** *(All India 2011)*
   a. Rhegmatogenous Retinal Detachment
   b. Tractional Retinal Detachment
   c. Vitreous Hemorrhage
   d. Eale's disease

132. **Exudative retinal detachment is/are seen in:** *(PGI Nov 2012)*
   a. Central serous retinopathy
   b. Scleritis
   c. Iritis
   d. Eclampsia

133. **Cause(s) of Exudative Retinal detachment:** *(PGI May 2011)*
   a. Posterior scleritis
   b. VKH syndrome
   c. DM
   d. Refractory hypertension
   e. Metastatic tumor of choroid

134. **Retinal breaks most commonly seen in** *(Recent pattern Nov/Dec 2016)*
   a. Upper nasal
   b. Upper temporal
   c. Lower nasal
   d. Lower temporal

135. **Subretinal demarcation lines (High water marks) indicate:** *(AIIMS Nov 2014)*
   a. Fresh rhegmatogenous retinal detachment
   b. Old rhegmatogenous retinal detachement
   c. Retinopathy of prematurity
   d. Retinitis pigmentosa

136. **Regarding rhegmatogenous retinal detachment, all of the following are correct except** *(AIIMS Nov 2014)*
   a. There is abnormal pull on the retina due to changes in the vitreous
   b. Anterior extent is up to Ora serrata
   c. Presents as floaters
   d. Management is usually surgical

137. **Shaffer's sign is seen in** *(Recent pattern 2015)*
   a. Rhegmatogenous retinal detachment
   b. Exudative retinal detachment
   c. Tractional retinal detachment
   d. Vitreous hemorrhage

138. **A 60 year old male patient operated for cataract 6 months back now complains of floaters and sudden loss of vision. The diagnosis is** *(AIIMS May 2001)*
   a. Vitreous hemorrhage
   b. Retinal detachment
   c. Central retinal artery occlusion
   d. Cystoid macular edema

Retinoblastoma

139. **Increased LDH in Aqueous Humor suggests a diagnosis of** *(All India 2009)*
   a. Galactosemia
   b. Retinoblastoma
   c. Glaucoma
   d. Gyrate atrophy

140. **The mother of a one and a half year old child gives history of a white reflex from one eye for the past 1 month. On computed tomography scan of the orbit there is calcification seen within the globe. The most likely diagnosis is:** *(All India 2005)*
   a. Congenital cataract
   b. Retinoblastoma
   c. Endophtalmitis
   d. Coats disease

141. **Retinoblastoma is associated with which chromosome?** *(NIMHANS 2016)*
   a. 13
   b. 11
   c. 17
   d. 15

142. **The most common presentation of retinoblastoma is:** *(AIIMS May 2013)*
   a. Leucocoria and pseudohypopyon
   b. Leucocoria and hyphema
   c. Leucocoria and strabismus
   d. Leucocoria an heterochromia irides

143. **All of the following statements about genetics of retinoblastoma are true, except:** *(Recent pattern 2015-16)*
   a. Rb1 gene is a tumor suppressor gene
   b. Rb1 gene is located on long arm of chromosome 13
   c. Hereditary retinoblastoma accounts for 90 percent of all cases
   d. Positive family history is seen in 10 percent of patients with retinoblastoma

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144. The most common mode of spread of Retinoblstoma is: *(All India 2012)*

a. Hematogenous b. Lymphatogenous
c. Optic nerve d. Trans-scleral

145. The most common mode of spread of retinoblastoma *(AIIMS May 2015)*

a. Optic nerve b. Lymphatics
c. Vascular d. Direct invasion

146. A 5 year old boy presents with leucocoria in the right eye which is diagnosed as diffuse retinoblastoma involving the entire globe. Examination of the left eye revealed a small 2–3 mm tumor in the periphery. What will be the ideal management of this patient: *(All India 2011)*

a. Enucleation of both eyes
b. Enucleation of right eye and observation for left eye
c. Enucleation of right eye and focal therapy of the left eye
d. Six cycles of chemotherapy

147. Poor prognostic factor for retinoblastoma includes:

a. > 4 mm size of tumor *(PGI May 2015)*
b. > 2 mm size of tumor
c. Associated glaucoma
d. Undifferentiated tumor cells
e. Sclera involvement

148. True about Retinoblastoma: *(PGI May 2012)*

a. It is most common primary intraocular tumor of childhood
b. It is most common secondary intraocular tumor of childhood
c. Commonly seen in young & middle-age adult
d. Most commonly seen in children

149. Most common primary intraocular tumor in children

a. Retinoblastoma *(Recent pattern July 2016)*
b. Malignant melanoma of choroid
c. Malignant melanoma of ciliary body
d. Rhabdomyosarcoma

150. Resse Ellsworth classification is for which of the following conditions *(Recent pattern Nov. 2016)*

a. Hypertensive retinopathy
b. Optic nerve glioma
c. Retinoblastoma
d. Choroidal melanoma

151. As regards to intraocular retinoblastoma, which one of the following statements is false: *(AIIMS May 2006*

a. 94% of the cases are sporadic
b. Patients with sporadic retinoblastoma do not pass their genes to their off-springs
c. Calcification in the tumor can be detected on ultrasound scan
d. Reese-Ellesworth classification is useful in predicting visual prognosis following Radiotherapy

152. A patient with known mutation in the 'Rb gene' is 'disease free' from Retinoblastoma. The patient is at highest risk of developing which of the following malignancies

a. Renal cell carcinoma b. Osteosarcoma
c. Pinealoblastoma d. Chondrosarcoma

153. Knudson's two stage hypothesis is for: *(PGI Dec 2000, PGI Dec 1999)*

a. Glaucoma b. Retinoblastoma
c. Optic Glioma d. Meningioma

154. Pseudorosettes are seen in : *(Recent pattern Dec 2014)*

a. Retinoblastoma b. Ophthalmic nodosa
c. Phacolytic Glaucoma d. Trachoma

155. Pseudoglioma differs from Retinoblastoma in that pseudoglioma is associated with : *(AI 2005)*

a. Decreased intraocular pressure
b. Blurring of vision
c. Enlargement of the optic foramen
d. All of the above

156. In retinoblastoma, after enucleation, which tissue is sectioned to find out systemic metastasis: *(AIIMS June 1999)*

a. Central retinal artery b. Sclera and episclera
c. Optic Nerve d. Vortex vein

157. A two year old child presents with leukocoria in the right eye since 2 months. On examination total retinal detachment is seen. USG B-Scan reveals the presence of a subretinal mass with calcification. What is the most probable diagnosis? *(AIIMS 2001)*

a. Coat's disease b. Retinoblastoma
c. Toxocariasis d. Retinal tuberculoma

158. Calcification is seen is all of the following except *(AIIMS May 2013)*

a. PHPV b. Retinoblastoma
c. Choroidal osteoma d. Optic nerve head drusen

159. Persistent primary Hyperplastic vitreous (PHPV) is associated with: *(All India 2008)*

a. Patau syndrome b. Edward syndrome
c. Trisomy 14 d. Downs syndrome

160. Which of the following is the most common complication after lens extraction in persistent hyperplastic primary vitreous? *(AIIMS Nov 2012)*

a. Retinal detachment b. Vitreous hemorrhage
c. Orbital cellulitis d. Keratitis

161. Which of the following is not found in PHPV? *(Recent pattern 2015)*

a. Cataract b. Microphthalmia
c. Leukocoria d. Calcification

162. Which of the following statements, concerning persistent hyperplastic primary vitreous (PHPV)is true?

a. It is generally unilateral
b. Visual prognosis is usually good
c. It may calcify
d. It is most easily differentiated from retinoblastoma by the presence of cataract or exophthalmos

Vitreous

163. The most common cause of vitreous hemorrhage in adults is: *(All India 2006)*

a. Retinal hole b. Trauma
c. Hypertension d. Diabetes

164. A 25 year old male gives history of sudden painless loss of vision in one eye for the past 2 weeks. There is no history of trauma. On examination the anterior segment is normal but there is no fundal glow. Which one of the following is the most likely cause? *(All India 2005)*

a. Vitreous haemorrhage b. Optic atrophy
c. Developmental cataract
d. Acute attack of angle closure glaucoma

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165. **Mucopolysacharide Hyaluronic acid is present in:** *(All India 2007)*
a. Aqueous Humor b. Vitreous Humor
c. Lens d. Cornea

166. **A vitreous sample has been collected at 9 pm. What advice would you like to give to the staff on duty regarding the overnight storage of the sample?** *(AIPG)*
a. The sample should be stored at 4 degrees Celsius
b. The sample should be incubated at 37 degrees Celsius
c. The sample should be kept in the deep freezer
d. The sample should be refrigerated for the initial 3 hours and then incubated

167. **When compared to blood, vitreous humour has higher concentration of:** *(AIIMS May 2015)*
a. Glucose b. Sodium
c. Bicarbonate d. Ascorbate

168. **Attachment of vitreous is Srongest at?** *(Recent pattern Dec 2013, Recent pattern 2016)*
a. Foveal region b. Back of lens
c. Across ora serrate d. Margin of optic disc

169. **Space of cloquet is phylogenetically related to-** *(Recent pattern July 2015)*
a. Hyaloid artery b. Central retinal artery
c. Central retinal vein d. Iris

170. **Muscae volitantes are seen in-** *(Recent pattern June 2014)*
a. Vitreous detachment
b. Vitreous hemorrhage
c. Remains of primitive hyloid vasculature
d. Eale's disease

171. **In a young patient presenting with recurrent vitreous hemorrhage, diagnosis is-** *(PGI June 2002)*
a. Eale's disease
b. CRVO
c. Proliferative retinopathy
d. Coat's disease

172. **A 25 year old male presents with painless sudden loss of vision, ocular and systemic examination is not contributory. What is probable diagnosis?** *(AIIMS Nov 2010)*
a. Retinal detachment b. Eale's disease
c. Glaucoma d. Cataract

173. **Eale's disease is** *(Neet pattern Dec 2012)*
a. Retinal hemorrhage b. Vitreous hemorrhage
c. Conjunctival hemorrhage
d. Choroidal hemorrhage

174. **Eales disease is** *(Recent pattern Dec 2013)*
a. Recurrent optic neuritis
b. Recurrent pappilloedema
c. Recurrent periphelbitis retinae
d. None

175. **All of the following are true of Eale's disease except**
a. Occurs in the young *(Recent pattern Nov 2014)*
b. Vitreous hemorrhage is present
c. Retinal detachment
d. Optic neuritis

176. **Treatment of choice for Eale's disease** *(Recent pattern Dec 2013)*
a. Antibiotics b. Corticosteroids
c. Antihistaminics d. Surgery

Miscellaneous

177. **In Von Hippel-Lindau Syndrome, the retinal vascular tumours are often associated with intracranial hemangioblastoma. Which one of the following regions is associated with such vascular abnormalities in this syndrome?** *(All India 2005)*
a. Optic radiation b. Optic tract
c. Cerebellum d. Pulvinar

178. **Optic cup develops into?** *(Recent pattern 2013)*
a. Lens b. Retina
c. Cornea d. Sclera

179. **How many mm from the limbus is the safest site of intravitreal injection?** *(Recent pattern July 2016)*
a. 1–2 mm b. 2–3 mm
c. 3–4 mm d. 4–5 mm

180. **Optic vesicle is derived from:**
a. Endoderm b. Mesoderm
c. Neuroectoderm d. Surface ectoderm

181. **Salt and pepper retinopathy is observed in all of the following except:** *(AIIMS May 2013)*
a. Fundus flavimaculatus
b. Congenital rubella
c. Thioridazine toxicity
d. After healing of macular edema

182. **Ocriplasmin is the newer drug used in which of the following?** *(AIIMS May 2013)*
a. Retinal break b. Vitreomacular adhesion
c. Submacular bleed d. Diabetic macular bleed

183. **All are ocular emergency except:** *(PGI May 2015)*
a. Eye injury
b. Sympathetic ophthalmitis
c. Retinal artery occlusion
d. CRVO
e. Bacterial endophthalmitis

184. **Epiretinal membrane is seen in** *(Recent pattern July 2016)*
a. Posterior vitreous detachment
b. Optic neuritis
c. Papilledema
d. Glaucomatous optic atrophy

185. **Fundoscopic finding of retinal hemorrhage with white centre is known as?** *(Recent pattern Dec 2015, 2017)*
a. Cotton wool spot b. Flame shaped hemorrhage
c. Roth spot d. Drusen

186. **Roth spots are seen in** *(Recent pattern Dec 2012)*
a. Bacterial endocarditis b. HTN retinopathy
c. DM retinopathy d. All

187. **Drugs causing macular toxicity when given intravitreally** *(Recent pattern Dec 2013, All India 2006)*
a. Gentamycin b. Vancomycin
c. Dexamethasone d. Ceftazidime

188. **The laser procedure, most often used for treating iris neovascularization, is:** *(AIIMS May 2006)*
a. Goniophotocoagulation
b. Laser Trabeculoplasty
c. Panretinal photocoagulation (PRP)
d. Laser Iridoplasty

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189. Retinal astrocytoma is seen in : *(Neet pattern Dec 2012)*

a. Tuberous sclerosis
b. Sturge weber syndrome
c. Von Hippel – Lindau syndrome
d. None

190. Photoretinitis is due to *(Recent pattern Dec 2013)*

a. Snow reflection
b. Solar eclipse
c. Blunt trauma
d. None of the above

191. Outer Blood-Retina Barrier is formed by

a. Tight junction between endothelial cells of retinal capillaries
b. Tight junctions between retinal pigment epithelial cells
c. Tight junction between endothelial cells of choriocapillaris
d. Tight junctions between non-pigmented ciliary epithelium

Most Recent Questions of 2019-2017

192. Hypotonic maculopathy is caused by all except?

a. Suprachoroidal haemorrhage *(AIIMS May 2017)*
b. Cyclodialysis
c. Perforated corneal ulcer
d. Filtration bleb leak

193. "Silent choroid" on FFA is feature of *(AIIMS May 2017)*

a. Best's disease
b. Age related macular degeneration
c. Stargardt's disease
d. Cystoid macular edema

194. 100 day glaucoma is seen in which of the following conditions?

a. Central retinal vein occlusion *(Recent pattern 2017)*
b. Central retinal arterial occlusion
c. Angle closure glaucoma
d. Primary open angle glaucoma

195. Ocular manifestations of dengue are all except *(AIIMS May 2018)*

a. Cataract b. Maculopathy
c. Vitreous hemorrhage d. Optic neuropathy

196. Cattle track appearance is seen in? *(Recent pattern 2017)*

a. Central retinal vein occlusion
b. Central retinal artery occlusion
c. Sarcoidosis
d. Hypertensive retinopathy

197. All are true about central retinal artery occlusion (CRAO) except? *(PGI May 2017)*

a. Most commonly occurs due to thromboembolism
b. Anterior chamber paracentesis is used for treatment
c. Sudden painful loss of vision
d. Occurs due to obstruction of retinal artery at the level of lamina cribrosa
e. Macular area shows cherry-red spot

198. Which of the following can be ophthalmic complication of DM except? *(PGI May 2017)*

a. Papillopathy
b. Snowflake cataract
c. Retinopathy
d. Rhegmatogenous retinal detachment
e. Cystoid macular edema

199. Sea fan retinopathy is seen in *(Recent question June 2018)*

a. Diabetes
b. Sickle cell retinopathy
c. Hypertension
d. Central retinal vein occlusion

200. Which of the following is the most radioresistant layer of retina? *(JIPMER Dec 2018)*

a. Retinal pigment epithelium
b. Rods and cones
c. Ganglion cell layer
d. Inner nuclear layer

201. Mizuo Nakamura phenomenon is seen in *(JIPMER Dec 2018)*

a. Congenital stationary night blindness (CSNB)
b. X linked retinitis pigmentosa
c. Congenital cone dystrophy
d. Leber congenital amaurosis

202. Blood retinal barrier is formed by *(JIPMER Dec 2018)*

a. Muller cells b. Amacrine cells
c. Horizontal cells d. Outer Plexiform layer

203. Treatment of retinoblastoma is by *(Recent question 2019)*

a. 5FU + Cisplatin + Vinblastine
b. Carboplatin + Etoposide + Vincristine
c. Cyclophosphamide + Etoposide + Vincristine
d. Cyclophosphamide + Doxorubicin + Etoposide

204. Retinitis pigmentosa is associated with deficiency of? *(Recent question 2019)*

a. Docosahexaenoic acid b. Eicosapentaenoic acid
c. Arachidonic acid d. Thromboxane

Most Recent Questions of 2019-2017 are given at the end

ANSWERS TO IMAGE-BASED QUESTIONS

1. Ans. (c) Direct ophthalmoscopy

The only confusion (if any) should be with Retinoscopy, as both the instruments look the same, but retinoscopy is usually performed from a distance of 1 meter as read in chapter 2.

2. Ans. (b) Fundus Examination

Option a – Optic disc can be examined by the Direct ophthalmoscope, but it is one part of the fundus view

Option b – Ophthalmoscopy is a clinical examination of the posterior segment of the eye/ Fundus examination. (**Fundus** is a view of the inner lining of the eye made up of the Sensory Retina, the Retinal Pigment Epithelium, Bruch's Membrane, and the Choroid).

Option c – Cornea may be examined, but the role is no more than of a torch.

Option d – Gonioscopy is done for it.

3. Ans. (d) It is done from a distance of 100 cm

Ref: Khurana optics 2/e, p. 384

Option a/b – Image characteristics

- Virtual and erect
- Magnified 15 times in emmetropes (more in myopes and less in hypermetropes)

Option c – Field of vision in direct Ophthalmoscopy

- With a 14X magnification, the field of view is 10 degree
- Or it is 2DD (disc diameters) = 3 mm.
- It is directly proportional to the size of the pupil
- It is directly proportional to the axial length of the eye
- It is inversely proportional to the distance between the subject and the observer's eye.

Option d – It is done with the examiner as close to the patient's eye as possible.

(Theoretically, at the anterior focal plane, 15.4 mm from the cornea)

4. Ans. (c) Can be used in cases of hazy ocular media

Option a – It is a hand-held instrument, used with the examiner standing or seated slightly above the patient. It can be performed in any position.

Option b – It is a uniocular examination, so Stereopsis (depth perception), Grade III of Binocular Single Vision is not possible.

Option c – The visibility is poor in cases of hazy media, so not of good use.

Option d – Because of high magnification, the field of view is smaller, thus, retinal periphery cannot be examined.

5. Ans. (b) Indirect ophthalmoscopy

(Used for Peripheral fundus examination)

6. Ans. (c) Virtual and erect image

Option a/c – the principle of Indirect ophthalmoscopy is to make the patient's eye highly myopic by placing a Convex (plus) lens in front of it, so that, the emergent rays of light are brought to focus as a real, inverted image between the convex lens and the observer's eye.

Option b – A dark room procedure with a good illumination (adjustable), to see through hazy media

Option d – Image is magnified 5 times with a +14D lens.

Magnification of the image depends upon

- Dioptric power of the convex lens used (+20D used commonly)
- Position of the convex lens in relation the eyeball
- Refractive state of the eyeball

7. Ans. (c) The field of observation is always larger than the field of illumination

Option a – Pupil of the patient should be dilated as a pre-requisite and the size of the pupil does not affect the field of observation.

Option b – Inversely proportional

Option c – Fact

Option d – By asking the patient to look in extreme gaze and by using the sclera indenter, the whole peripheral retina, up to the ora serrata can be examined.

8. Ans. (b) The patient is examined in the sitting position

Option a – This is a Binocular procedure, that is why Stereopsis is possible. Binocularity is achieved by reducing the interpupillary distance from around 60 cm to 15 cm with the help of prisms/mirrors.

Option b – Preferably examined in supine position, with the head slightly raised

Option c – Fact

Option d – Optic disc finding, part of Fundus examination, though direct ophthalmoscopy is preferred.

9. Ans. (a) Neovascularization of the disc

Ref: Kanski, 7/e, p. 546

Neovascularization of the disc is defined as neovascularization at the disc or within 1 DD (visible as **tuft of vessels** in the image).

10. Ans. (b) Proliferative diabetic retinopathy

11. Ans. (b) Vitreous hemorrhage

Ref: Khurana 4/e, p. 354

Option a – most common cause of visual loss in DR and NPDR – Macular edema

Option b – most common cause of visual loss in PDR

Option c – most common cause of blindness in DR

Option d – Neovascularization signifies proliferation

12. Ans. (a) Hard exudates

In a fundus photograph – always first visualize the optic disc and then the macula (by its position temporal to optic disc and relatively avascular zone), artery (thinner in cross-section and red) and vein (thicker in cross-section and darker red).

In the image given for the question

White arrow – a red colored lesion – flame shaped hemorrhage

Black arrow – whitish yellow, fluffy lesion with indistinct margins over a blood vessel – Cotton wool spots

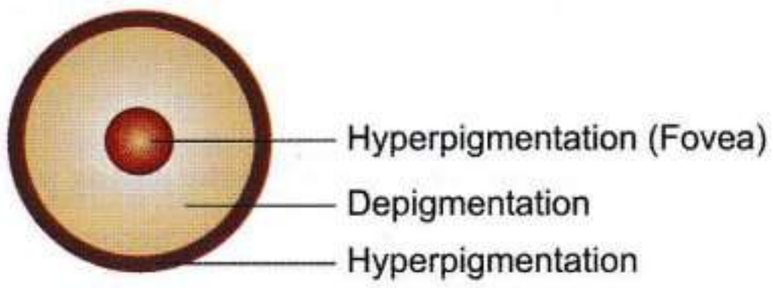
Box – artery crossing over the vein – leading to some change in course of vein – AV crossing changes –Salus, Bonnet, Gunn sign)

13. Ans. (c) Hypertensive retinopathy

Based on the history and the fundus picture in the right eye (characteristic AV crossing sign, arteriolar attenuation) with nephropathy, Hypertensive retinopathy is the more likely diagnosis.

14. Ans. (b) Bull's eye maculopathy

Bull's eye maculopathy - The macula shows an area of **hyperpigmentation in the fovea** which is **surrounded by a zone of depigmentation**. The depigmented zone is in turn **surrounded by an annulus of hyperpigmentation**. The appearance is that of a bull's eye maculopathy.
(The patient must be assumed to be taking chloroquine/ hydroxychloroquine for treatment of rheumatoid arthritis causing Bull's eye maculopathy)



15. Ans. (c) Stickler syndrome

Bull's eye maculopathy-Causes

- Startgardt disease
- Chloroquine and Hydroxychloroquine (safer)
- Cone and cone – rod dystrophy
- Clofazimine retinopathy
- Hallevorden Spatz syndrome
- Olivopontocerebellar atrophy
- Lipofuscinosis
- Leber congenital amaurosis

SC_3HOL_2

16. Ans. (a) Bull's eye maculopathy is reversible

Option a/b - Chloroquine Toxicity

- **Pre-maculopathy: Reversible**, Normal VA, Central Scotoma
- Early to severe maculopathy – VA is reduced, **Bull's eye lesion, Irreversible** and progressive even after discontinuation of the drug
- **Vortex keratopathy/Cornea Verticillata:** golden-brown corneal epithelial deposits, innocuous, reversible, no related to dose or duration of treatment

(The finding of corneal verticillata bares no correlation with retinal toxicity and is not an indication to stop the medication)

Option c/d – Risk for maculopathy

- Daily dose >3.5 mg/kg or 250 mg
- Cumulative dose >460 mg
- Duration of treatment > 5 years
- Evidence of renal or hepatic insufficiency

17. Ans. (b) Fluorescein angiography

Tests now suggested as inadequate for screening (by American academy of Ophthalmology) include

- Biomicroscopy alone
- Fundus photography
- Time-domain OCCT
- Fluorescein angiography
- Full-field ERG
- Amsler grid
- Color vision testing
- EOG

Baseline and **annual screening examinations include**

- **Biomicroscopy** and 10-2 Humphrey visual field analysis
- **Along with any one of the following**
  - Fundus autofluorescence
  - Spectral domain OCT
  - Multifocal ERG

Facts

The hallmark of Chloroquine toxicity is Bilateral Pigmentary retinopathy.

18. Ans. (b) Niemann-Pick Disease Type

Option B - Niemann-Pick Type A disease is a severe neurodegenerative disorder of infancy. By six months of age affected babies experience feeding difficulty, recurrent vomiting and enlargement of the spleen and liver, which causes the abdomen to appear, distended. Some children with the disease have a "cherry-red spot" in the retina of the eye. Death usually occurs between 2 and 4 years of age.
Option C - Tay Sachs disease never presents with Hepatosplenomegaly.
Option D - Gaucher's disease presents also with anemia, thrombocytopenia, etc. and skeletal abnormalities.

19. Ans. (b) Central retinal artery occlusion

Sudden painless loss of vision – characteristic for CRAO except in cases of Giant cell arteritis.

An afferent pupillary defect is found in CRAO, where I/L direct and C/L consensual light reflex are lost and I/L consensual light reflex is present. (Afferent pathway is formed by Optic nerve).

Red fovea – cherry red spot at macula- feature of CRAO.

20. Ans. (a) Wet age related macular degeneration

Patient sees WAVY lines, characteristic feature for patients with macular disease, can be tested on Amsler's Grid.

The history of smoking also supports the diagnosis of ARMD, as smoking doubles the risk for it.

Sudden painless loss of vision occurs in the WET stage as compared to the gradual loss in DRY stage.

The fundus picture also shows drusen along with CNV and subretinal macular hemorrhage.

21. Ans. (b) Three monthly injections of Ranibizumab

Option a – LP is done for extrafoveal lesions, rarely done now a days.
Option b – Anti-VEGF drugs are the mainstay of treatment for Wet ARMD as has been seen in many trials such as MARINA, ANCHOR, Pronto trial etc

Option c – PDT can be done, but used only if

- Purely occult CNV
- Predominantly classical CNV, subfoveal, not larger than 5400 microns amd a visual acuity of 6/60 or better.

Option d – Wet ARMD needs to be treated. Observation may be done in cases of Dry ARMD.

22. Ans. (c) Retinitis pigmentosa

In the blood picture – Acanthocytes (spur cells) can be seen scattered – in a child – it indicates the possibility of Abetalipoproteinaemia – which can be associated with Retinitis pigmentosa.

23. Ans. (a) Ischemic CRVO

Ref: Kanski, 7/e, p. 554

In the image, severe hemorrhages can be seen giving the characteristic Tomato-ketchup appearance seen in cases of Ischemic CRVO.

Hypertension is the most common risk factor.

24. Ans. (b) Retinal pigment epithelium

Ref: Kanski, 7/e, p. 632

In the FFA image, smoke stack appearance can be seen along with OCT image where Neurosensory detachment is visible. Along with the history and the patient being a female, we can diagnose it as a case of CSR – central serous retinopathy.

In CSR, the defect lies in the RPE – diffuse hyperpermeable defects.

25. Ans. (b) PDR

Ref: BSCS, American Academy of Ophthalmology, p. 21-24

History of diabetes mellitus in the patient hints towards probable Diabetic retinopathy

In the image, multiple small white dots are visible – signifying microaneurysms

In the superior perivascular area and near the optic disc hyperfluorescence is seen – which is due to Leakage from the Neovascularization. (Neovessels seen as tuft of vessels in early phase and show leakage in late phase)

Neovascularization signifies proliferation – diagnostic of PDR

26. Ans. (c) Cystoid macular edema

Ref: Kanski 7/e, p. 635,638

On examination of FFA image, hyperfluorescence is seen at the macula (avascular area temporal to macula) due to leakage and accumulation of dye within microcystic spaces in OPL, in a Flower petal or Petalloid pattern, diagnostic of cystoid macular edema.

History of cataract surgery further supports the diagnosis, as CME occurs after phacoemulsification and other ECCE surgeries as a complication.

27. Ans. (d) Treatment is by Focal laser photocoagulation

(Ref: Parson's 22/e, p. 315,316)

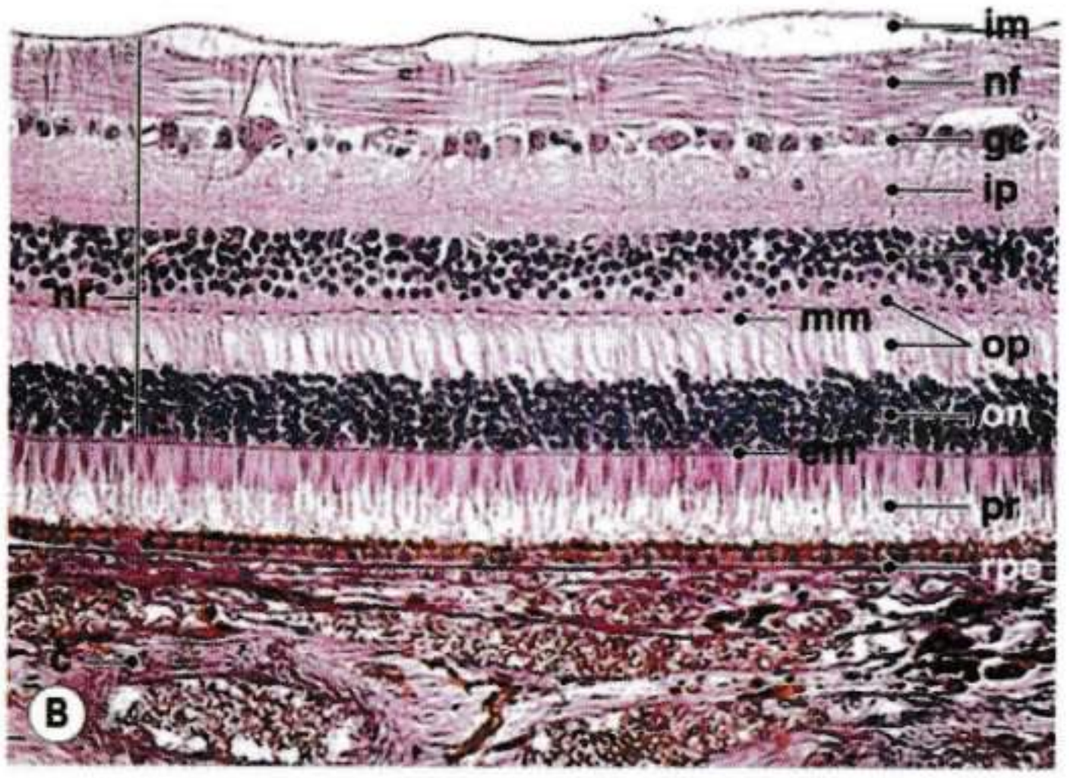
Circinate Retinopathy

- It occurs in elderly as part of hypertensive of diabetic retinopathy
- Occurs due to chronic edema around macula which leads to accumulation of macrophages laden with lipids (exudates) forming a ring around it
- Can be treated with photocoagulation

28. Ans. (c) Inner plexiform layer

(Ref: Ocular Pathology by Yanoff, Sassani 7/e, p. 353)

Brown colored melanosomes may be seen in Retinal pigment epithelium enabling to recognize the outermost layer of retina. Ganglion cells – recognized as a single layer of contiguous cells



29. Ans. (c) Vitreous hemorrhage

Ref: Kanski 7/e, p. 731

ANSWERS TO MULTIPLE CHOICE QUESTIONS

30. Ans. (d) Memicane

Ref: The Eye: Basic Sciences in Practice 2/e, p. 212

Interphoto receptor matrix contains

- Interphotoreceptor Retinal binding protein **(IRBP)**
- **Proteoglycans** - Glycosaminoglycans
  - Sulphated/Non-sulphated chondroitin
  - Hyaluronic acid
- Fibronectin
- Silaloprotein associated with rods and cones **(SPARC)**
- Intercellular Adhesion molecule I **(ICAM-1)**
- Hyaluronic Acid Receptor **(CD44 antigen)**
- **Lysosomal enzymes**
  - Matrix metalloproteinases
  - Tissue inhibitors of Metalloproteinases (TIMP)

31. Ans. (b) 2 disc diameter

Ref: Khurana anatomy 2/e, p. 241

32. Ans. None

Ref: Grays 39/e, p. 716, 706, Khurana anatomy 2/e, p. 150-151

Retina receives its blood from all the option provided in the question

33. Ans. (d) Foveola

Ref: Harrison 19/e, 40/e-1, p. 1932

- Vision is most acute at the foveola, where only cones are found; each cone directly relays to a single ganglion cell

34. Ans. (b) Ganglion cell layer

Ref: Functional visual loss is differential from organic loss by visual evoked potential (VEP)

- **Most radiosensitive cells in retina: Rods & Cones**
- **Most radioresistant: Ganglion cells**

35. Ans. (a) Cones present) & (e) Visual acuity highest

Ref: Khurana 4/e, p. 249-51; Parson's 20/e, p. 291

Refer text

36. Ans. (b) Optic disc

Ref: Anatomy and physiology of eye 2/e, p. 141

37. Ans. (b) Inferior pole

Ref: Kanski 7/e, p. 323

- **The neurorentinal rim** is the tissue between the outer edge of the optic disc and the physiological cup.
- It is broadest Inferiorly, followed by Superior, Nasal and Temporal **(the ISNT rule)**

38. Ans. (c) 15 times

Ref: Parson's 20/e, p. 132

Refer text

39. Ans. (a) Occult choroidal neovascularisation

Ref: Kanski 5/e, Ch 14

As opposed to fluorescein, indocyanine green is a larger molecule that binds completely to plasma proteins, causing it to remain in the choroidal vessels.

40. Ans. (a) Image is virtual and erect

Ref: Khurana 5/e, p. 600 (4/e, p. 568)

Refer text

41. Ans. (a) a wave- arises..., (b) b wave - d/t..., (c) b-wave... (d) c wave - representing....

Ref: Parson's 22/e, p. 109-10; Kanski 7/e, p. 648-649

42. Ans. (a) In choroidal circulation it passes..., (c) Albumin binding is less ...

Ref: Parson's 22/e, p. 142-43

- With a molecular weight of 376, fluorescein ***diffuses freely out of all capillaries except those of the central nervous system, including the retina***"
- Fluorescein is 80% bound, whereas indocyanine green is 98% bound.
- Fluorescein stimulated by (465–495 mm), whereas ICG 805 nm.

43. Ans. (c) 15 times

Ref: Parson's, 19/e, p. 135

Magnification obtained with direct ophthalmoscope

- In **emmetropes is about 15 times** and
- **Least magnified is seen in hypermetropes,**
- Most **magnified is seen in myopes.**

44. Ans. (c) B-Scan USG

Ref: Parson's 21/e, p. 337, 94

45. Ans. (b) EOG (Electroculogram)

Ref: Kanski 6/e, p. 23-24; Essentials of Ophthalmology by Basak 4/e, p. 32

46. Ans. (d) Electroretinogram

Ref: Kanksi 7/e, p. 653

47. Ans. (b) Macular cones

Ref: American Academy of Ophthalmology, BCSC, Section 12/p. 38

Multifocal ERG tests cone-generates responses that subtend 25° radially from fixation by producing a topographic map of the retina. It can help in early detection and follow up of various macular disorders.

48. Ans. (c) Magnification is 5 times

Ref: Parson's 20/e, p. 91

49. Ans. (c) More than 185%

Ref: Kanski, 7/e, p. 649

50. Ans. (b) 25 cm

Distant direct ophthalmoscopy is done from a distance of 20-25 cm, and the features of the red reflex are noted.
Option a/d are the same (mathematical conversion), so rule them out distance for retionscopy.
Option c – distance for Direct ophthalmoscopy.

51. Ans. (b) Indirect ophthalmoscopy

Ref: Khurana 4/e, p. 276

- History of photopsia and sudden loss of vision in an 18 years old girl with use of spectacles for last 10 years suggest that the patient is myopic and has developed retinal detachment (one of the complication of high myopia)
- **Retinal detachment is best examined by indirect ophthalmoscopy with scleral indentation.**

52. Ans. (a) Antecubital vein

Ref: Diagnostic Procedures by Nema, 2/e, p. 177

The technique of fluorescein angiography comprises rapidly injecting 5 mL of 10% solution of sterile sodium fluorescein dye **in the antecubital vein** and taking serial photographs of the fundus.

53. Ans. (b) Rodes and Cones

Ref Kanski 6/e, p. 23,24

54. Ans. (b) Central 20 degrees of vision

Ref Parson's 21/e, p. 924; Kanski 7/e, p. 598

- Metamorphopsia is a phenomenon wherein the patient perceives objects to have an altered, irregular contour or shape. For example, graph paper lines may be bent or obscured in areas.

- This can be reviewed for any changes over time using an Amsler grid, which tests the central 20 degrees of vision.
- It is associated with diseases affecting the macula such as central serous choroidopathy, age related macular degeneration, diabetic macular oedema and macular hole.
- Metamorphopsia is a phenomenon wherein the patientperceives objects to have an altered, irregular contour or shape. For example, graph paper lines may be bent or obscured in areas.
- This can be reviewed for any changes over time using an Amsler grid, which tests the central 20 degrees of vision.
- It is associated with diseases affecting the macula such as central serous choroidopathy, age related macular degeneration, diabetic macular oedema and macular hole.

55. Ans. (a) Purtscher's retinopathy

Ref: Yanoff & Duker 4/e, p. 679

It is a blockage of the retinal capillaries by emboli leading to multiple haemorrhages and cotton wool spots throughout the retina.

56. Ans. (c) Head trauma

Ref: Parson's 22/e, p. 619

57. Ans. (a) Pseudoxanthoma elasticum

Ref: Parson's 22/e, p. 329

58. Ans. (a) As early as feasible

Ref: Parson's 19/e, p. 591

Refer text

59. Ans. (c) Immediately

60. Ans. (d) Inner nuclear layer

Ref: Kanski 7/e, p. 536

61. Ans. (b) Neovascularization at disc

Ref: Parson's 21/e, p. 307

Refer text

62. Ans. (d) Exophotocoagulation

Ref: Oxford Textbook of Medicine 4/e, p. 350 current Geriatric Diagnosis & Treatment (2004)/127

Treatment of advanced proliferative diabetic retinopathy (PDR) with extensive viteroretinal fibrosis, tractional retinal detachment or dens recurrent vitreous hemorrhage requires a surgical procedure called posterior vitrectomy or parsplana vitrectomy

Advanced PDR with dense vitreous hemorrhage	Advanced PDR with extensive fibrovascular epiretinal membrane	Advanced PDR with tractional retinal detachment and/or tear
Vitrectomy with removal of opaque vitreous gel and endophotocoagulation	Vitrectomy with removal of fibrovascular epiretinal membrane and endophotocoagulatin (dissection of membrane)	Vitrectomy and reattachment of detached or torn retina by endophotocoagulation or other methods.

63. Ans. (b) Pars plana vitrectomy

Refer text– Indications for vitrectomy

64. Ans. (d) Tamoxifen

Ref: Yanoff 3/e, p. 645

Tamoxifen is known to cause retinopathy and macular edema as an adverse effect. It is not used in the treatment of Diabetic Macular edema or retinopathy.

- Ruboxistaurin–PKC inhibitor
- Pyridazinones/Spiroimides/corbotyliz acid — aldose reductase inhibitors
- Benfoliamine–↓levels of AGE's

65. Ans. (b) Arteriovenous nipping

[Ref: Khurana 4/e, p. 260-62; Parson's 20/e, p. 294-98]

"Arteriovenous nipping is found in hypertensive retinopathy"

66. Ans. (b) Non-proliferative DM

Ref: Khurana 4/e, p. 430-31; Parson's 20/e, p. 568

Lesions of retina and choroid form the most important **indications for PRP**

- **Diabetic retinopathy** in which pan-retinal photocoagulation (PRP) is carried out for ***proliferative*** *retinopathy* and focal or grid-photocoagulation for ***exudative maculopathy.***
- Peripheral retinal vascular abnormalities such as ***Eales' disease***, **proliferative sickle cell disease, Coats' disease** and ***retinopathy of prematurity***.
- **Intraocular tumors** such as retinoblastoma, malignant melanoma and choroidal hemangioma.
- ***Macular diseases***, such as central serous retinopathy, and age-related macular degeneration (ARMD).
- For sealing of **holes in retinal detachment**.

In NPDR-only diabetic control is advised by ETDRS

Retinal laser treatment is needed in all laser retinal disorders causing breakage or neovascularization. Photocoagulation is done by lasers (argon, diode, frequency doubled Nd: YAG).

67. Ans. (a) Vitreous hemorrahage

Ref: Parson's 20/e, p. 88-89

It occurs when the vitreous, a gel-like substance that fills about 80 percent of the internal eye, slowly shrinks. As the vitreous

shrinks, it becomes somewhat stringy, and the strands can cast tiny shadows on the retina.

People with diabetes are more likely to have and patients will sometimes visualize individual red blood cells floating around within their vitreous)(sort of looks like hundreds of discrete, little peppercorns).

68. Ans. (a) Neovascularisation (d) Vitreous detachment

Ref: Khurana 4/e, p. 260-62; Parson's 20/e, p. 294-98

69. Ans. (a) DR, (b) Hypertensive.., (c) AIDS & (e) Toxaemia..

Ref: American Academy of Ophthalmology Section 12/p. 160; Parson's 20/e, p. 485,292]/p. 249

70. Ans. (b) Diabetic retinopathy

Ref: Kanki 7/e, p. 536

Hemorrhages can be seen in a number of vascular disorders or retina, but, dot and blot haemorrhages are characteristic for DR, even though they may be seen in other conditions also.

71. Ans. (a) Argon green

Ref: Kanski 7/e, p. 543

72. Ans. (c) Immediate scatter... > (a) Immediate focal laser

Ref: American Academy of Ophthalmology, BCSC, Section 12/ p. 109-129

Option a – Although the ETDRS reported that focal laser photocoagulation should be applied in patients with CSME, irrespective of the level of visual acuity, the patients can be observed closely, especially if most of the edema is in the foveal avascular zone.

Option b – The DCCT finding apply to type 1 DM patients.

Option c – NVD with VH is a case of High risk Proliferative diabetic retinopathy.

High risk PDR

- NVD greater than ETDRS standard photograph 10A (about 1/3 disc area)
- NVD with vitreous hemorrhage or pre-retinal hemorrhage
- NVE greater than ½ disc area with vitreous hemorrhage or pre-retinal hemorrhage

Treatment with Pan retinal photocoagulation should be performed immediately.

Option d – Macular edema has been defined by clinical examination in ETDRS and not only by FA or CT.

73. Ans. (a) Very severe NPDR has a 45%...

Option a – In the ETDRS, it was found that Severe NPDR had a 15% chance and Very severe NPDR a 45% chance of progression to high risk PDR within 1 year.

Option b – Contraindicated if FAZ > 1000 microns

Option c – PRP should be done in multiple sittings

Option d – In ETDRS study, aspirin use did not alter progression of retinopathy and did not reduce the risk of vitreous hemorrhage.

74. Ans. (c) Are usually greater than 1 disc diameter in size

Option a/d – CWS are composed of accumulations of neuronal debris within the nerve fiber layer. They result from disruption of nerve axons.

Option b – in diabetic retinopathy persist for 3 to 6 months whereas in hypertensive retinopathy tend to disappear at **around 6** weeks.

Option c – are usually less than 1 disc diameter in size.

75. Ans. (a) Retinal pigment epithelium dysfunction

Ref: Harrision 17/e, p. 2286-2287; Yanoff and Duker 2/e, p. 877-880; Parson's 20/e, p. 294-298

Pathogenesis of macular edema is due to the same changes as overall for DR.

76. Ans. (a) Microaneurysm

Ref: Parson's 21/e, p. 360; Kanski 7/e, p. 536

77. Ans. (b) Mild visual loss

Ref: Kanski 7/e, p. 541

- It is characterized by **marked visual loss**
- Fluorescein angiography show areas of non-perfusion which in early cases are in the form of enlargement of foveal avascular zone (FAZ), later on area of capillary dropouts are seen and in advanced cases precapillary arterioles are blocked.

78. Ans. (c) Proliferative diabetic retinopathy

Ref: Basics of Ophthalmology 2/e, p. 1219; Kanski 7/e, p. 546

Indications for PRP

- Proliferative DR
- Ischemic CRVO-at the first sign of rubeosis iridis
- Neo-vascular glaucoma (NVG)

79. Ans. (a) Dilated Retinal vein

Ref: Yanoff 3/e, p. 625

Central Retinal vein occlusion and Ocular Ischemic Syndrome due to carotid artery stenosis are both associated with dilated Retinal veins and hence this feature cannot be used to distinguish these conditions.

80. Ans. (a) Serum homocysteine level

Ref: Am J Ophthalmol. 2000 May; 129 (5): 640-4 Hyperhomocysteinemia: a risk factor for central retinal vein occlusion

Transient obscuration of vision followed by diminution of vision suggests central retinal vascular pathology (CRVO or CRAO). Diabetes is a risk factor for central retinal vascular occlusion.

Serum homocysteine level would be the investigation needed to screen the patient for hyperhomocysteinemia. Hyperhomocysteinemia has been found to be an independent risk factor for central retinal vascular occlusion.

81. Ans. (c) More.... & (d) Disc edema.

Ref: Khurana 6/e, p. 286; Parson's 22/e, p. 517-18

- Ocular ischemic syndrome refers to a rare condition resulting from chronic ocular hypoperfusion secondary to carotid artery stenosis (90% stenosis)
- *Risk factors* include male gender, old age (60-90 years), smoking, for carotid stances hypertension, diabetes mellitus and hyperlipidaemia.
- The *manifestations* of carotid occlusive disease include ***Amaurosis fugax*** (transient retinal ischaemic attack)

Retinal artery occlusion (due to embolus), Transient cerebral ischaemic attacks (TIA), Stroke, and Asymetrical diabetic retinopathy.

82. Ans. (b) Central retinal vein occlusion

Ref: Kanski 8/e, p. 543

83. Ans. (b) Ischemic CRVO is..., (c) On Fluorescein Angiography, (d) Inversion of the b wave

Option a – Rubeosis Iridis occurs in about 20% patients with **CRAO at 4 -5** weeks, thus earlier than in CRVO (3months)
Option b – Splash tomato or Tomato ketchup appearance of fundus
Option c – FA in Ischemic CRVO shows

- Marked delay in arteriovenous transit time (>20 seconds)
- Extensive areas of capillary non-perfusion
- Vessel wall staining
- >10 disc areas of non-perfusion being associated with an increased risk of neovascularization

Option d – normally the b wave amplitude is larger than a wave, inversion of the b:a wave ratio is an ominous sign.

Delay in the 30Hz cone flicker response is also seen as a potentially ominous sign
Option e – Prophylactic PRP should not be done even with marked ischemia in the absence of neovascularization. Once neovascularization is detected, PRP should be done promptly

84. Ans. (b) Hypertensive retinopathy

Ref: Parson's 19/e, p. 326

Recurrent headache with arteriolar attenuation (G1) with CWS and flame shaped hemorrhage(s) suggest the diagnosis of hypertensive retinopathy.

85. Ans. (d) Tractional retinal detachment can be seen

Ref: Parson's 22/e, p. 312

Option a – Papilledema is the hallmark of malignant (accelerated) hypertension
Option b – vision is severely affected and the prognosis is poor
Option c – Choroidopathy is rare, but seen with accelerated hypertension

- Elschnig spots
- Siegrist streaks

Option d – Exudative RD may be seen

86. Ans. (d) Exaggerated light reflex

- In later stage of hypertension, there is ***exaggerated light reflex (copper-wire appearance) or highly exaggerated light reflex (silver-wire appearance)***

87. Ans. (d) Gaucher's disease

Ref: Wright and Spiegel - Paediatric ophthalmology and starbismus 2/e, p. 799; Inherited Metabolic Diseases: A Clinical Approach edited by Georg F. Hoffmann, Johannes Zschocke, William L. Nyhan

All of the options given in the question may lead to cherry red spot.

But, in such a scenario gaucher's disease in the best answer as gaucher's Type 1 does not present with cherry red spot (most common form 99% cases). It is seen in cases of Gaucher's diease type 2 and type 3.

Cherry-Red spot and Related Macular Signs in Metabolic Disorders

Gangliosidoses
Infantile GM1 gangliosidosis: gerneralized gangliosidosis, Classic cherry-red spot in 50% of cases
Late infantile/iuvenile GM gangliosidosis: Atypical cherry-red spot a rare finding
Acute infantile GM 2gangliosidosis
Tay-Sachs disease and Sandhoff variant - Classic cherry-red spot in most cases.
Subacute GM_2gangliosidosis - Cherry-red spot or diminished foveal light reflex
Niemann-pick Disease
Type A: sphingomyelin lipidosis - Cherry-red like in many cases, often extension of retinal haze beyond macula
Type B: sphingomyelin lipidosis - Maculo halo syndrome; infrequently a cherry-red spot
Type C: Cholesterol lipidosis - Cherry-red like spot in some cases
Gaucher's Diseases Type 3: subacute neuronopathic form - Macular grayness in some cases
Metachromatic leukodystrophy
Infantile form - Macular grayness; cherry-red like spot in some cases
Krabbe's Disease Infantile onset variant - **Cherry-red like spot –** (Not Cherry-red spot)
Farber disease - Macular grayness or cherry-red -like spot in some cases
Sialidosis Type I and Type II - Cherry-red spot
Galactosialidosis - Cherry-red spot
Neuronal ceroid lipofuscinosis
Juvenile from: Spielmeyer-Siogren
Bull's –eye maculopathy
Fucosidosis - Bull's-eye maculopathy

Metabolic diseases with cherry-red spots
Sialidosis type I and II
Galaciosialidosis (early-infantile)
Tay-Sachs disease [gangliosidosis type 2 (GM_2), variant B, infantile]
Sandhoff disease (GM_2, variant O, infantile)
Gangliosidosis type 1-gangliosidosis (infantile)
Niemann-Pick disease type A
Gaucher's disease type 2
Farber disease
Metachromatic leukodystrophy

88. Ans. (a) CRAO

Ref: Kanski 7/e, p. 560

89. Ans. (c) Krabbe's disease

Ref: Refer text

90. Ans. (d) Orbital mucomycosis

Ref: Yanoff 3/e, p. 592

CRAO in orbital mucormycosis results from ***vascular invasion which is the hallmark of orbital mucormycosis****. Mucormycosis*

is typically associated with thrombosis of vessels affected by the inflammatory process reflecting the vascular tropism of the fungus. Central Retinal artery Occlusion (CRAO) may be the presenting sign in a small subset of patients of Orbital mucormycosis.

91. Ans. (a) Central retinal artery occlusion

Ref: Kanski 7/e, p. 562

Narrowing of arteries and veins with sludging of and segmentation of blood column – Cattle trucking/ Boxcarring.

92. Ans. (d) Central retinal artery occlusion

Ref: Kanski 8/e, p. 552

93. Ans. (b) CRAO

Ref: Parson's 21/e, p. 313

94. Ans. (d) Associated with peripheral telangiectasias

Refer text

95. Ans. (b) Coats disease

Ref: Kanski 7/e, p. 582

- Unilateral loss of vision with squint, exudates & RD points towards Coats disease

Familial exudative vitreoretinopathy (FEVR)
- Usually a positive family (AD, XLR)
- **Bilateral but may be asymmetrical involved**
- Unlike ROP not associated with LBW or prematurity
- Peripheral vascular telangiectasias
- Fibrovascular proliferation with tractional retinal detachment
- Massive subretinal exudates
- May present with leukocoria & squint

96. Ans. (a) Outer plexiform layer

Ref: Kanski 7/e, p. 536

- **Exudates:** are waxy yellow lesions with relatively distinct margins (in comparison to soft exudates which have irregular fluffy margins) are caused by chronic localized retinal edema

They develop at the junction of normal & edematous retina and are composed of lipoprotein and lipid filled macrophages. They are located mainly in outer plexiform layer.

97. Ans. (b) Retinopathy of prematurity

Ref: Parson's 21/e, p. 310

98. Ans. (b) Laser photocoagulation of both eyes

Ref: www.nnfguidelines.org

99. Ans. (a) Resolv..., (b) Laser or.. & (c) No..

Ref: Parson's 20/e, p. 299-300; O.P. Ghai 7/e, p. 645

"In 80% of cases, retinopathy of prematurity resolves spontaneously with restoration of normal vascularization of the retina"

100. Ans. (d) Can be treated with laser

Ref: Parson's 21/e, p. 316

"Early recognition followed by prophylactic laser/cryotherapy may be beneficial"

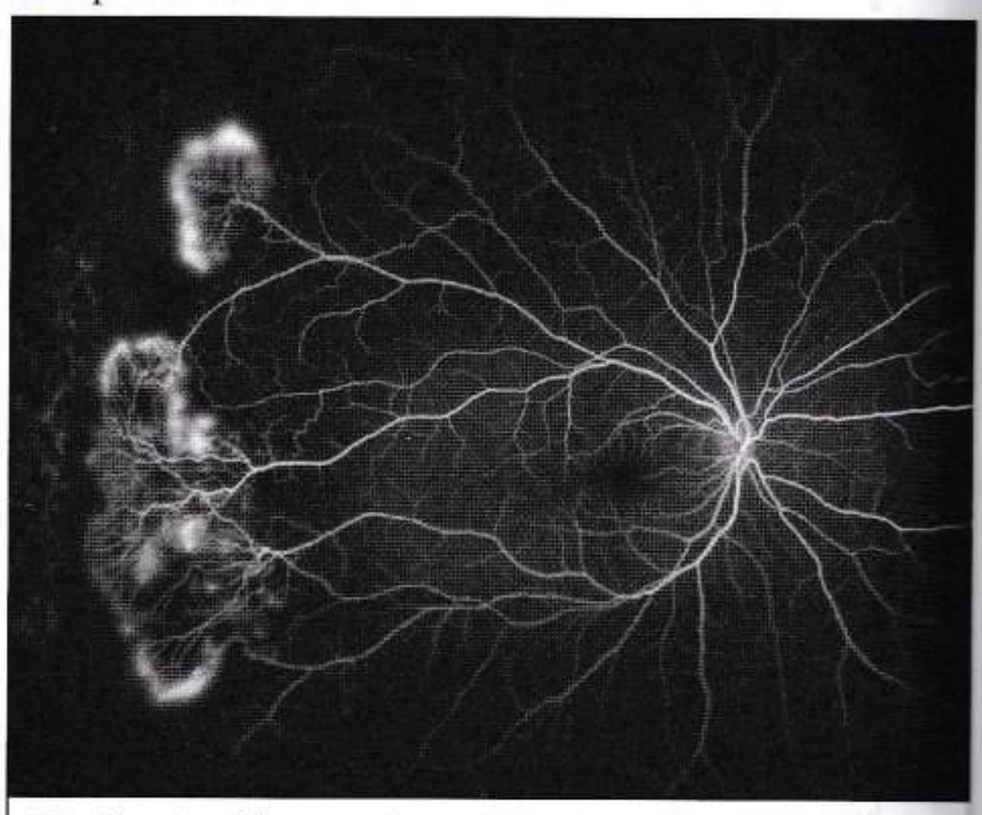
101. Ans. (a) Laser photocoagulation

Ref: Yanoff 3/e, p. 606-611

102. Ans (c) Sickle cell retinopathy

Ref: Kanski 7/e, p. 569/570; Parson's 22/e, p. 319

Stickle cell retinopathy is most commonly seen associated with **sickle-cell C disease** and Thalassemia. In stage 3 retinopathy–sprouting of new vessels from AV anastomoses have a 'sea-fan' configuration. Other signs:
- Venous tortuosity
- Salmon patches–preretinal hemorrhages
- Black sunbursts
- Angioid streaks
- Papilledems



FFA showing fibrovascular proliferations formed like sea-fans

103. Ans. (a) Occult CNV

Ref: Yanoff 3/e, p. 542-543

The greatest utility of ICG angiography is in the identification and delineation of poorly defined or **occult CNV**'.

Also useful to diagnose suspected **RPE detachment**.

104. Ans. (c) Enquire about the use of steroids

Presence of focal foveal detachment with a central scotoma (indicating probable macular lesion) in a young male is suggestive of the diagnosis of central serous retinopathy. **Corticosteroid** use is one of the etiological factors and needs to be tapered and stopped.

105. Ans. (d) Cystoid macular edema

Ref: Kanski 7/e, p. 635; Yanoff 3/e, p. 491

106. Ans. (e) Lower incidence with intracapsular cataract extraction than extracapsular cataract extraction

Ref: Khurana 5/e, p. 212, 290; Parson's 20/e, p. 268; CMDT 6/e p. 1221, 164; Kanski 7/e, p. 635

'CMO is higher following extracapsular extraction.'

Etiology

- As postoperative complication following ***cataract extraction (Irvine-Gass syndrome)*** and penetrating keratoplasty.

- Retinal vascular disorders, *e.g.*, ***diabetic retinopathy***, central retinal vein occlusion, branch retinal vein occlusion (BRVO), retinal telangiectasia (*e.g.*, Coat's disease), periphlebitis retinae (Eales disease) & ***hypertensive retinopathy***
- Intraocular inflammations, *e.g.* pars planitis, posterior uveitis, Behcet disease.
- As a side effect of drugs, *e.g.* following use of adrenaline eyedrops, especially for aphakic glaucoma **PGE_2 analogues**.
- Retinal dystrophies, *e.g.* retinitis pigmentosa.
- Vitreo macular traction
- **Miscellaneous causes:** Macular epiretinal membrane (ERM), intraocular tumors & collagen vascular disease

107. Ans. (e) Prognosis after...

Ref: Khurana 6/e, p. 296-97, 5/e, p. 291-93, 459; Parson's 22/e, p. 256-57; Kanski 7/e, p. 615-622

- *The preferred treatment modality currently is intravitreal injection of anti-VEGF agents like* Bevacizumab, ranibizumab, & aflibercept
- *Photodynamic therapy (PDT)* is the treatment of choice after anti-VEGF injection for subfoveal and juxtafoveal classic CNVM
- *Transpupillary thermotherapy (TTT)* with a diode laser (810 nm) may be considered for subfoveal occult CNVM. PDT is definitely better than TTT but is very costly.

108. Ans. (a) May recur in same or Opposite eye; (b) Smoke-stack pattern; (c) Self-limited; (d) Treatment is required in minority of the cases

Ref: Kanski 7/e, p. 632; Ryam Retina 5/e, p. 1291

109. Ans. (b) Prostaglandin E2 analogues

Ref: Becker-Shaffer Glaucoma 8/e, p. 400

Drugs causing Cystoid macular edema

- Benzylalkonium chloride
- Timolol
- Dinoprostone (PGE2 analogues)

110. Ans. (a) Vitamin A

Ref: American Academy of Ophthalmology, BCSC, Section 12/p. 64

Substantial evidence has been given by AREDS study that taking high antioxidant vitamins and minerals on regular basis can decrease the risk of AMD progression.

AREDS2 study has said that vitamin A should not be given in prophylaxis as it leads to lung cancer in smokers. ARMD is common in smokers.

Instead, lutein and zeaxanthin should be given.

111. Ans. (d) Just wait and watch for spontaneous recovery

Ref: Kanski 7/e, p. 633

Smoke stack appearance on FFA-CSR.

112. Ans. (c) Central serous retinopathy

Ref: Khurana 4/e, p. 273

113. Ans. (b) Central serous retinopathy

Ref: Textbook of Ophthalmology by Ahmed 2/e, p. 317; Khurana 4/e, p. 273

114. Ans. (d) Cystoid macular edema

Ref: Kanski 7/e, p. 635; Yanoff 3/e, p. 491

115. Ans. (b) Best disease

Ref: Kanski 6/e, p. 672, 667, 693, Harrison 18/e, p. 2190

- Best disease (Autosomal dominant)
- Bassen-Kornzweig syndrome (Autosomal Recessive)
- Gyrate Atrophy (Autosomal Recessive)
- Lawrence-Moon-Biedl Syndrome (Autosomal Recessive)

116. Ans. (b) Oguchi's disease

Ref: Kanski's Clinical Ophthalmology 7/e, p. 662, American Academy of Ophthalmology Section 12/p. 222

117. Ans. (a) Pigmentary Retinal Dystrophy

Ref: Kanski 7/e, p. 653

The classical triad of arteriolar attenuation, bone spicule pigmentation and waxy disc pallor along with ..... Ring scotoma suggests the diagnosis to Typical Retinitis Pigmentosa or pigmentary Retinal Dystrophy.

118. Ans. (a) Stargardt's disease

Ref: Spiral Manual of ocular Diagnosis and Therapy (Elsevier) 6/e, p. 197; Kanski 7/e, p. 657 665; Yanoff 3/e, p. 560-563

Disease	ERG	EOG
Best's Vitelliform Dystrophy	**Normal**[Q]	**Depressed**/[Q] Extinguished
Stargardt's Disease	**Normal** (May be depressed)	**Normal** (May be depressed)
Retinitis Pigmentosa	Depressed/ Extinguished	Depressed/Absent
Cone-Rod Dystrophy	Depressed/ Extinguished	Depressed

119. Ans. (b) Best's Vtielliform Dystrophy

Ref: Ryan's retina, 6/e, p. 857

120. Ans. (d) Retinitis pigmentosa

Ref: Dejong's Neurological Examination, 7/e, p. 134

In annular or ring scotoma there is loss of vision in a doughnut shape with relative sparing of fixation and the far periphery. These types of scotomas are generally due to retinitis pigmentosa.

121. Ans. (b) Marfan's syndrome

Ref: Yanoff and Duker 2/e, p. 820

122. Ans. (b) Hallervorden-Spatz disease

Ref: Yanoff and Duker 2/e, p. 820

123. Ans. (b) Rhodopsin

Ref: Retinitis Degenerative Diseases and Experimental therapy p. 252

- Several different rhodopsin gene mutations have been identified in the pedigrees with autosomal dominant retinitis pigmentosa.

124. Ans. (a) PSC

Ref: Yanoff and Duker 2/e, p. 818; Kanski 7/e, p. 654

- Retinitis pigmentosa is associated with posterior subcapsular cataract (PSC)

Retinal pigment degeneration such as retinitis pigmentosa, Usher's syndrome and gyrate atrophy are associated with cataract, which are usually subscapular opacities.

125. Ans. (a) Absence of rod function

126. Ans. (a) Sensory retina

Ref. Kaski 7/e, p. 689, Parson's 22/e, p. 330

127. Ans. (c) Separation of sensory retina from pigment epithelium

Ref: Kanski 7/e, p. 689, 701

- **Retinal detachment:** Separation of NSR from RPE, leading to accumulation of fluid in sub retinal space
- **Retinoschisis (splitting of retina)**

Typical/degenerative split in OPL	Reticular/congenital split at NFL

128. Ans. (a) Primary retinal detachment

Ref: Kanski 7/e, p. 691

A retinal break is a full thickness defect in the NSR

Tears	Holes
caused by dynamic traction MC- superotemporal	caused by chronic atrophy

129. Ans. (b) Sulfur hexafluoride (SF6)

Ref: Kanski 7/e, p. 715

130. Ans. (a) Hyperopia

Ref: Parson's 21/e, p. 323

131. Ans. (a) Rhegmatogenous Retinal Detachment

Ref: Kanski 7/e, p. 721, 704

132. Ans. (a) Central serous retinopathy; (b) Scleritis; (d) Eclampsia

Ref: Khurana 4/e, p. 278-79, 275-277; Kanski 7/e, p. 710-712

133. Ans. (a) Posterior..., (b) VKHS, (d) Refra.. & (e) Metas...

Ref: Khurana 4/e, p. 278-79, 275-277; Kanski 6/e, p. 710-712

134. Ans. (b) Upper temporal

Ref: Kanski 7/e, p. 691

135. Ans. (b) Old rhegmatogenous retinal detachment

Ref: Kanski 7/e, p. 707; Parson's 22/e, p. 332

136. Ans. All statements are true

Ref: Kanski 7/e, p. 700 – 708

PVD leads to dynamic vitreoretinal traction on the retina leading to retinal tears.

137. Ans. (a) Rhegmatogenous retinal detachment

Ref: Parson's 22/e, p. 332, 617; Kanski 7/e, p. 706

138. Ans. (b) Retinal detachment

- Amongst the given opitons, retinal detachment and hemorrhage can cause floaters with sudden loss of vision. However, vitreous hemorrhage is not a late complication of cataract surgery.

139. Ans. (b) Retinoblastoma

Ref: Parson's 22/e, p. 380

Lactic Dehydrogenase (LDH) in Aqueous Humor

- The enzyme Lactic Dehydrogenase (LDH) has been reported to be present in small amounts in the normal aqueous humor where isoenzymes 3,4 and 5 predominate
- The activity of lactic dehydrogenase (LDH) in aqueous is measured as **a ratio Aqueous LDH/Plasma**
- The LDH level in aqueous is grossly increased in Retinoblastoma where the **Aqueous/Plasma ratio of LDH is usually greater than 1.5** (It is usually less than 0.60 in a variety of other conditions)
- The **source** of LDH in the aqueous of patients with Retinoblastoma is the **release of cytosolic enzymes into the surrounding medium**
- Retinoblastoma is associated with a high degree of **necrosis** which allows more free enzymes to reach the aqueous and hence a high level of LDH is observed in patients with Retinoblastoma
- LDH of aqueous humor is often used as a marker for Retinoblastoma.

140. Ans. (b) Retinoblastoma

Ref: Parson's 22/e, p. 400, Kanski 7/e, p. 514

Presence of leukocoria (white pupillary reflex) and calcification within the globe in a one and a half year old child is almost diagnostic of retinoblastoma.

141. Ans. (a) 13

Ref: Parson's 22/e, p. 378

142. Ans. (c) Leucocoria and strabismus

Ref: Yanoff & Duker 4/e, p. 794 Parson's 22/e, p. 378

"The most common presenting manifestation of retinoblastoma is a white glow in the pupil (leukokoria). This appearance is caused by reflection of light from the white intraocular tumor. The second most common presenting manifestation is strabismus, which maybe either esotropia or exotropia.

143. Ans. (c) Hereditary retinoblastoma accounts for 90 percent of all cases

Ref: Kanski 8/e, p. 498-499

144. Ans. (c) Optic nerve

Ref: Parson's 22/e, p. 378

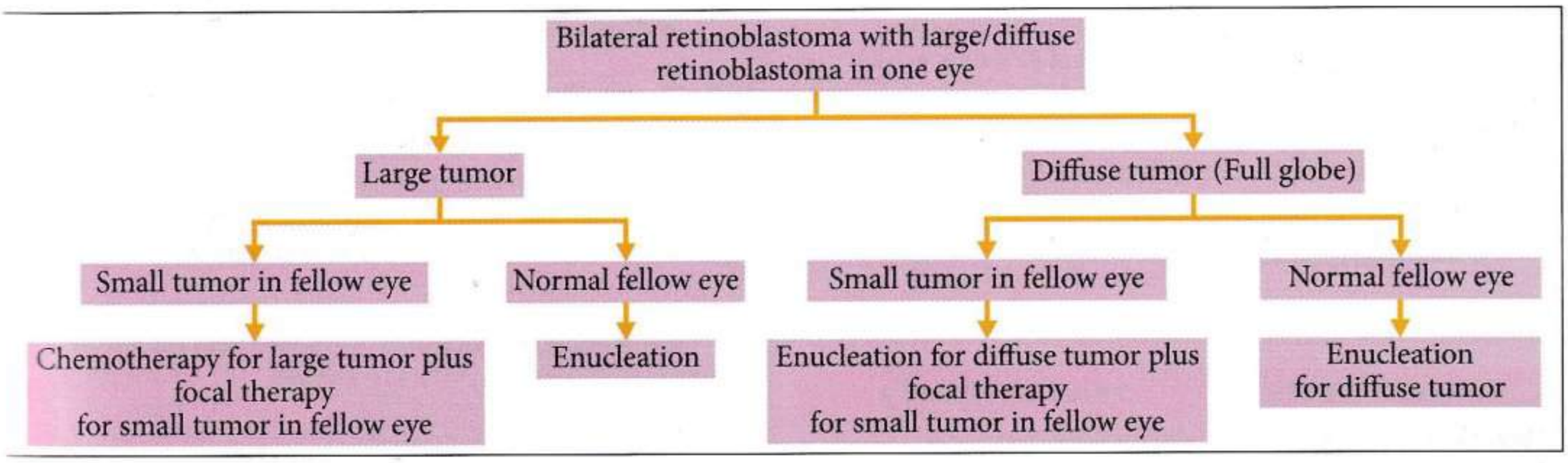
The most common route of spread of Retinoblstoma is direct invasion through the optic nerve with extension into the central nervous system.

145. Ans. (d) Direct invasion > (a) Optic nerve

Ref: Retinoblastoma by Wilson/p. 30

146. Ans. (c) Enucleation of right eye and focal therapy of the left eye

Ref: Yanoff 2/e, p. 1047; Other References


Bilateral retinoblastoma with large/diffuse retinoblastoma in one eye
Large tumor
Diffuse tumor (Full globe)
Small tumor in fellow eye
Normal fellow eye
Small tumor in fellow eye
Normal fellow eye
Chemotherapy for large tumor plus focal therapy for small tumor in fellow eye
Enucleation
Enucleation for diffuse tumor plus focal therapy for small tumor in fellow eye
Enucleation for diffuse tumor

147. Ans. (a) > 4 mm size of tumor; (c) Associated glaucoma; (d) Undifferentiated tumor cells; (e) Sclera involvement

Ref: Khurana 6/e, p. 306-07; Parson's 22/e, p. 379-80; Robbins 9/e, p. 1339; Retina by Ryan 5/e, p. 2117

148. Ans. (a) It is most common primary intraocular tumor of childhood; (d) Most commonly seen in children

Ref: Parson's 20/e, p. 357-58; OP Ghai 7/e, p. 594

"Retinoblastoma is the most common primary ocular tumor of childhood. About 90% cases are diagnosed by age 3-4 yrs & 98% by 5 yrs" (O.P. Ghai 7/e, p. 594)

149. Ans. (a) Retinoblastoma

Ref: Kanski 7/e, p. 510

Retinoblastoma – most common **intraocular** tumor in children.
Rhabdomyosarcoma – most common **orbital malignant** tumor in children.

150. Ans. (c) Retinoblastoma

Ref: http://eyewiki.aao.org/Retinoblastoma; Retina by Ryan, 5/e, p. 2114

In the 1950's, the Reese-Ellsworth classification system was developed to predict the prognosis after treatment with radiation, but in 1990 the focus shifted from EBRT to chemotherapy and the classification followed now is ICRB).

151. Ans. (b) Patients with sporadic retinoblastoma do not pass their genes to their off-springs

Ref: Yanoff & Duker 2/e, p. 1043)

- All the familial cases can pass their genes to their offspring (i.e. Are heritable or germinal), & even 1/3 of sporadic cases are heritable.

152. Ans. (b) Osteosarcoma

Ref: Pathology and Genetics of Tumors of Soft tissue and Bone (Who Classification of Tumors); Oncology and Basic Science' by Damrone (Lippincott/Williams); Robbins

'Second site primary malignant tumors refer to non metastatic tumors arising in disease free patients. Tumors associated with retinoblastoma include osteosarcoma, fibrosarcoma, chondrosarcoma, Ewing's sarcoma, Epithelial malignant tumor, lymphoma, leukemia melanoma, brain tumors and pinealoblasstomas. ***Osteogenic sarcomas are the most frequent second site neoplasms in all the published series'.***

153. Ans. (b) Retinoblastoma

Ref Kanski 7/e, p. 520

Deletion or inactivation of RB gene by two mutations (Knudson's two hit hypothesis) results in occurrence of retinoblastoma.

154. Ans. (a) Retinoblastoma

Ref Kanski 7/e, p. 520

155. Ans. (a) Decreased intraocular pressure

Ref: Parson's 22/e, p. 379

The intraocular pressure is raised in retinoblastoma while it is reduced in **pseudoglioma (conditions simulating retinoblastoma due to leukocoria)**.

156. Ans. (c) Optic nerve

Ref: Khurana 4/e, p. 283

After enucleation, optic nerve is examined and if it shows tumor invasion, postoperative radiotherapy to the orbital apex and chemotherapy are given.

157. Ans. (b) Retinoblastoma

Ref: Yanoff & Duker 4/e, p. 794-795

158. Ans. (a) PHPV

Ref: Parson's 21/e, p. 335

159. Ans. (a) Patau syndrome

Ref: Yanoff 4/e, p. 433

- PHPV is an uncommon congenital ocular anomaly in which the hyaloid vasculature system of primary vitreous fails to involute/regress
- It is **usually unilateral**[Q] (but bilateral PFV does occur)
- Insufficient levels of vitreous endostatin may be pathogenic to PHPV

Causes/Associations of Bilateral PHPV

- Trisomy 13 (Patau syndrome)
- Mild microphthalmos

Types

Anterior PHPV/PFV	Posterior PHPV/PFV
Abnormality confined to anterior segment and often **involves the lens**	Abnormality confined to posterior segment and **lens is usually clear**
Typical presentation Unilateral leucocoria	**Typical presentation** Unilateral Leucocoria, strabismus, Nystagmus
Signs & complications • Retrolental mass into which elongated ciliary processes are inserted • Cataract • Shallow Anterior chamber and angle closure Glaucoma • Recurrent intraocular haemorrhage • Microphthalmia	**Sign & complications** • A dense white membrane or a prominent retinal fold extending from the optic disc to ora serrata • Preretinal membrane • **Tractional Retinal folds** and detachment • Retinal dysplasia and optic nerve hypoplasia (may be) • Microphthalmia
Treatment Vitteoretinal surgery in selected early cases to salvage vision	**Treatment** Treatment is not possible

Differentiating features from retinoblastoma are:
- Microphthalmos
- Cataract
- Lack of calcification
- Unilaterality

160. Ans. (a) Retinal detachment

Ref: Article-Approach to cataract with persistent hyperplastic primary vitreous Sudarshan Khokhar, Lalit Kumar Tejwani, Gaurav Kumar, and Radkhi Kushmesh Journal of Cataract and Refractive Surgery, 2011-08-01, Volume 37, Issue 8, Pages 1382-1385

"When the cataract is significant, surgery is required to clear the visual axis. However, surgery for PHPV is complicated by a high rate of retinal detachment.

161. Ans. (d) Calcification

Ref: Paediatric Pathology, volume 1, p. 420

162. Ans. (a) It is generally unilateral

Ref: Parson's 22/e, p. 343

163. Ans. (d) Diabetes

Ref: Parson's 22/e, p. 344

164. Ans. (a) Vitreous hemorrhage

Ref: Kanski 7/e, p. 730

Sudden painless loss of vision with absence of fundal glow and a normal anterior chamber, in absence of trauma (spontaneous) is consistent with a diagnosis of spontaneous vitreous hemorrhage.

Vitreous hemorrhage	*Sudden painless loss of vision*
Optic atrophy	Gradual painless loss of vision
Developmental cataract	Gradual painless loss of vision
Acute angle closure glaucoma	Sudden painful loss of vision

165. Ans. (b) Vitreous Humor

Ref: Harper 27/e, p. 553-554

Location of Major Glycosaminoglycans[Q]

Glycosaminoglycan	Major Location
Hyaluronic acid [SVLC]	• Synovial fluid • **Vitreous humor** • Cartilage • Loose connective tissue
Chondroitin Sulphate (CBC)	• Cartilage • Bone • Cornea
Keratan sulphate (KS)	• **Cornea (KSI)** • Loose connective tissue (KS II)
Heparin	• Mast cells
Heparan sulphate	• Aortic wall • Skin fibroblasts

166. Ans. (a) The sample should be stored at 4 degrees Celsius

167. Ans. (d) Ascorbate

Ref: Khurana Anatomy 2/e, p. 132-133

Vitreous compared to plasma has

Higher CK cl Glutamic acid. Serine aminoacid.
- Ascorbic acid
- Potassium

- Chloride
- Glutamic acid and Serine amino acids

Lower

- Soluble proteins
- Glucose
- Bicarbonate
- Phosphate

Equal

- Sodium
- Calcium

> ✱ **Vitreous potassium levels increase in the first 100 hours after death, can be forensically used to determine time of death**

168. Ans. (c) Across ora serrata

Ref: Renu Jogi 4/e, p. 246

The part of vitreous about 4 mm across the ora serrate is known as the "base of vitreous" where the attachment is strongest.

169. Ans. (a) Hyaloid artery

Ref: Parson's 22/e, p. 342

It is the embryonic remnant of hyaloid artery.

170. Ans. (c) Remains of primitive hyloid vasculature

Ref: Khurana 6/e, p. 259; Parson's 22/e, p. 617

Muscae volitantes are physiological vitreous opacities and represent the ***residues of primitive hyaloid vasculature***.

171. Ans. (a) Eale's disease

Ref: Pearson's 22/e, p. 344

Eale's disease is characterized by ***recurrent bilateral vitreous hemorrhage in young adult (20-30 yrs) males***.

172. Ans. (b) Eale's disease

Ref: Kanski 7/e, p. 585; Pearson's 22/e, p. 344

- Both Eale's disease and Retinal detachment are causes of **painless sudden loss of vision**, however Eale's disease is a much more common cause than RD in a **young male**. Ocular and systemic examinations in both the conditions may be normal.

Eale's disease

- It is an **idiopathic inflammatory**, **Bilateral** disease with a triad of occlusion, periphlebitis, and neovascularization
- It is characterized by **recurrent**, bilateral **vitreous hemorrhage** usually in a **young adult** (20–40 years of age)
- **Complications** include Tractional RD, rubeosis iridis, glaucoma and cataract
- Strongly associated with tuberculoprotein hypersensitivity

T/t

- **DOC: In inflammatory stage is oral corticosteroids**
- Pan retinal photocoagulation (PRP) for **active disease**
- Visual prognosis is good

173. Ans. (b) Vitreous hemorrhage

174. Ans. (c) Recurrent periphelbitis retinae

175. Ans. (d) Optic neuritis

176. Ans. (b) Corticosteroids

177. Ans. (c) Cerebellum

Ref: Kanski 7/e, p. 522-523

VHL syndrome

- AD condition – 3p26 –VHL gene
- CNS hemangioma
  - Cerebellum
  - Spinal cord
  - Medulla/pons
  - Retinal vascular tumours capillary hemangiomas (25% cases)
- Pheochromocytoma
- Renal carcinoma

178. Ans. (b) Retina

Ref. Gray's anatomy 39/e, chapter 43

Refer chapter 1

179. Ans. (c) 3–4 mm

Ref: Kanski 7/e, p. 688

Please refer to Chapter 1

180. Ans. (c) Neuroectoderm

Ref: Sadler, TW (1990). Langman's medical embryology (6/e). Williams and Wilkins

181. Ans. (d) After healing of macular edema

Salt and Pepper fundus is a nonspecific term to describe areas of hypopigmentation due to atrophic retinal changes (salt) with pigmentry alterations from pigment migration (pepper) in large portions of retina.

Differential diagnosis of salt and pepper appearance of fundus

- Congenital **s**yphilis
- Congenital **r**ubella
- Drug toxicities: Thioridazine (**P**henothiazines) choroquine, and deferoxamine
- Infections: **M**easles, **M**umps, **R**ubella
- **S**targardt's disease (also known as fundus flavimaculatus)
- **R**efsum disease
- **K**earns–Sayre syndrome
- **C**ystinosis
- **U**sher syndrome
- **L**eber congenital amaurosis
- Carrier states of
  - **C**horoideremia
  - **A**lbinism
  - **R**etinitis pigmentosa

Mnemonic

SRP on MMR in SRK CUL CAR
(cool)

182. Ans. (b) Vitreomacular adhesion

Ref: www.dos-times.org/pdfs/2014/dos_nov_2014 pdf/p. 23

- **Ocriplasmin** (Serine protease microplasmin) is a recombinant truncated form of human plasmin (27.2 KDa), having proteolytic activity against fibronectin and laminin, two major components of vitreoretinal interface
- USFDA approved it in October 2012 for
  - Mild to moderate symptomatic vitreomacular adhesion (VMA), visual acuity ≥ 6/12
  - Moderate VMA with visual acuity ≤ 6/24
- Dosage is 0.125 mg intravitreal injection single dose

183. Ans. (d) CRVO

Ref: Khurana 6/e, p. 437-38; Parson's 22/e, p. 399

184. Ans. (a) Posterior vitreous detachment

Ref: American Academy of Ophthalmology, BCSC, Section 12 p. 97; Kanski 7/e, p. 625; Parson's 22/e, p. 342

An epiretinal membrane (ERM) is a semitranslucent, avascular, fibrocellular membrane on the inner retinal surface along the internal limiting membrane of the retina. ERM can be either

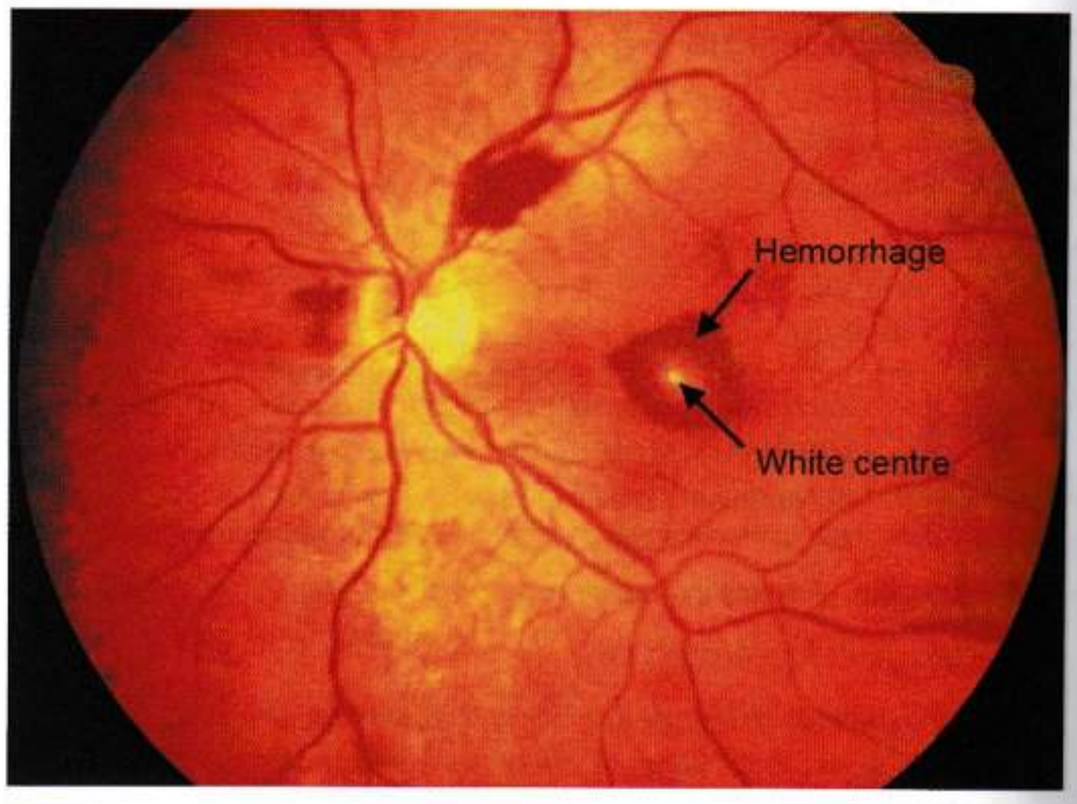
- **Idiopathic** – related to an abnormality of the vitreoretinal surface in conjunction with Posterior vitreous detachment (PVD)
- **Secondary**
  - Following surgery for RD (most common cause)
  - Retinal vascular disease (CRVO)
  - Uveitis
  - Trauma
  - Pan-retinal photocoagulation
  - Contraction of membrane leads to retinal wrinkling, macular pucker obstruction and CME.

185. Ans (c) Roth spot

Ref: Kanski 8/e, p. 575; Parson's 22/e, p. 324

Roth Spots – retinal hemorrhages with white centres occur in

- Acute leukemias (Lymphocytic)
- Thrombocytopenia in aplastic anemia
- Infective endocarditis
- SLE
- HIV retinopathy
- Diabetes and hypertension



186. Ans. (a) Bacterial endocarditis

187. Ans. (a) Gentamycin

Ref: Drug induced ocular side effects, Fraunfelder 4/e, p. 65

Campochiaro et al (1994)-A localized infarct is the end result of the gentamycin toxicity with discrete geographic involvement with non-perfusion not corresponding to vascular pattern.

188. Ans. (c) Paretinal photocoagulation (PRP)

Ref: Shields 6/e, p. 300

Neovascularization of iris (rubeosis iridis) is seen in conditions which cause retinal ischemia, like DR, CRVO.

Ablation of the peripheral retina with laser (usually argon) photocoagulation is the first line therapy for most cases.

189. Ans. (a) Tuberous Sclerosis

Ref: Textbook of Ocular Pathology, by Yanoff p. 53; Kanski 7/e, p. 518

Astrocytomas are most frequently associated with tuberous sclerosis, NF1 and retinitis pigmentosa

Neurofibromatosis I	Tuberous Sclerosis[Q]	Sturge- Weber syndrome	Von- Hippel- Lindau[Q]
Optic nerve and chiasmal tumor	Retinal astrocytoma	Buphthalmos (Glaucoma)	**Retinal angiomatosis** (Capillary hemangioma of retina)
Sphenoid wing tumor		Choroidal hemangioma	
Buphthalmos			
Plexiform neurofibroma			
Retinal astrocytoma			

Correlate Box

- 60% sporadic
- 40% AD
- Phacomatosis with triad of epilepsy, MR, adenoma sebacium

190. Ans. (b) Solar eclipse

Ref: Parson's 22/e, p. 326

- Photo retinitis is associated with religious sun gazing, solar eclipse observing, telescopy solar viewing, exposure to the flash of the short-circuiting of a strong current
- Due to exposure to IR rays

191. Ans. (b) Tight junctions between retinal pigment epithelial cells

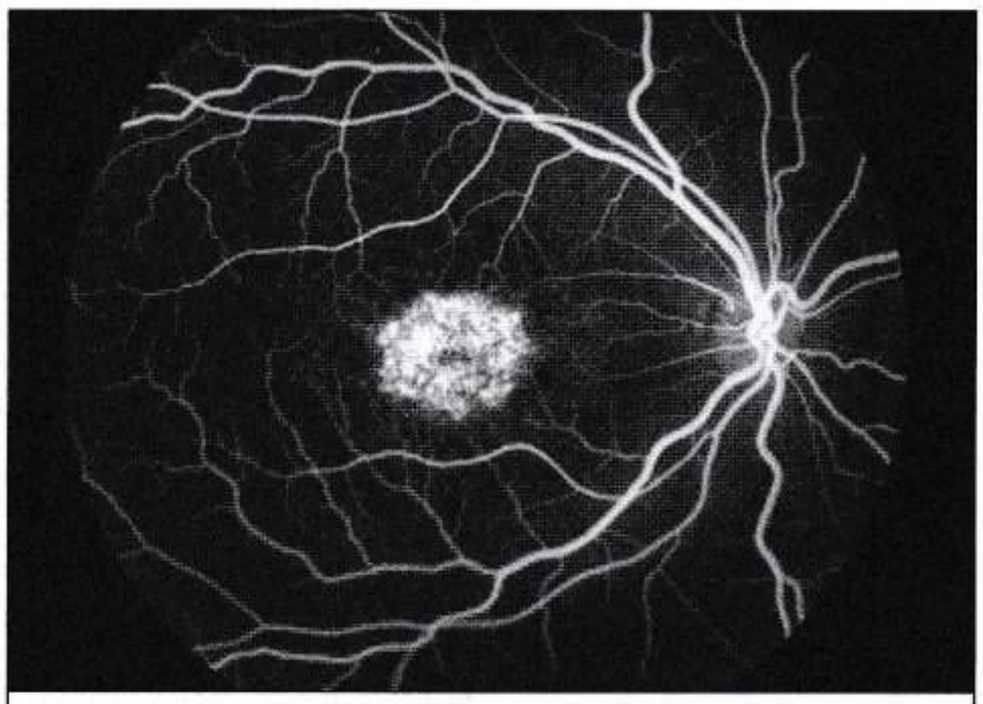
Ref: Khurana Anatomy and Physiology, 2/e, p. 60

192. Ans. (a) Suprachoroidal haemorrhage

Ref: Kanski 8/e, p. 637

193. Ans. (c) Stargardt's disease

Ref: Kanski 7/e, p. 660-662; Parson's 22/e, p. 337



FA shows hyperfluorescence at macula and a dark choroid (relative hypofluorescence of the choroid instead of the generalized choroidal flush seen in a normal FA) – Dark Choroid sign in Stargardt's disease

194. Ans. (a) Central retinal vein occlusion

Ref: Kanski 7/e, p. 557

195. Ans. (a) Cataract

Ref: American Academy of Ophthalmology, BSCS, Section 9/ p. 219

- Dengue fever – caused by Flaviviridiae and transmitted by Aedes aegypti

Ocular manifestations

- Petechial subconjunctival hemorrhage – **most common** manifestation
- Maculopathy (bilateral and asymmetric) – in 10% patients after one month of onset of systemic disease, causing sudden loss of vision and central scotoma
- Optic disc hyperemia
- Intraretinal hemorrhages with periphlebitis
- Yellow subretinal dots
- RPE mottling
- Fovealitis

196. Ans. (b) Central retinal artery occlusion

Ref: Kanski 7/e, p. 562; Parson's 22/e, p. 321

197. Ans. (a) Most commonly occurs due to thromboembolism; (c) Sudden painful loss of vision

Ref: Kanski 7/e, p. 559, 563

- Presentation is with sudden and profound loss of vision, Painless, except in Giant cell arteritis
- Atherosclerosis related thrombosis at the level of lamina cribrosa is by far the most common underlying cause of CRAO, accounting for 80% cases

198. Ans. None of the above

Ref: Khurana 6/e, p. 193, 277, 280; Parson's 22/e, p. 313-317, 369

- Diabetes causes Snowflake cataract, CME and retinopathy – well known facts
- **Diabetic papillopathy** – seen in young insulin dependent diabetics. It is often bilateral and optic nerve function/vision is not affected. Swollen disc with overlying telangiectatic vessels is diagnostic.
- ***Combined tractional-rhegmatogenous*** *retinal detachments are often seen in proliferative diabetic retinopathy, PVR, sickle cell retinopathy, and penetrating ocular injuries – Ryan retina 5/e, p. 1619*

199. Ans. (b) Sickle cell retinopathy

Ref: Parson's 22/e, p. 319

200. Ans. (a) Retinal pigment epithelium

Ref: Ryan's retina 6/e, p. 1219-1223

Radiation retinopathy

- Posterior pole is most sensitive to changes
- Primary radiation damage – inner layers of retina (Inner Plexiform, Inner Nuclear and Outer Plexiform layer)
- Most radioresistant – Retinal pigment epithelium
- MC clinical presentation – Macular edema or ischemia

(This has been a controversial topic for years with a lot of answers. This answer has been written based on various standard textbooks and answers from reputed teaching doctors)

201. Ans. (a) Congenital stationary night blindness (CSNB)

Ref: Retina by Ryan 6/e, p. 1012; Kanski 7/e, p. 662

Seen in Oguchi disease which is classified as CSNB with abnormal fundus

202. Ans. (d) Outer Plexiform layer

Ref: Retina by Ryan 6/e, p. 657; Khurana's Anatomy 2/e, p. 151

Blood retinal barrier at 2 levels

- **Inner** – Non-fenestrated capillaries of the retinal vessels (superficial capillary network in NFL and deep capillary network between INL and OPL)
- **Outer** – tight junctions of RPE

203. Ans. (b) Carboplatin + Etoposide + Vincristine

Ref: Ryan's retina 6/e, p. 2392; Kanski 8/e, p. 502; Parson's 22/e, p. 381

Chemotherapy agents commonly used for treatment of retinoblastoma are

	Age ≤ 36 months	Age > 36 months
Vincristine	0.05 mg/kg	1.5 mg/m^2
Etoposide	5 mg/kg	150 mg/ m^2
Carboplatin	18.6 mg/kg	560 to 600 mg/m^2

204. Ans. (a) Docosahexaenoic acid

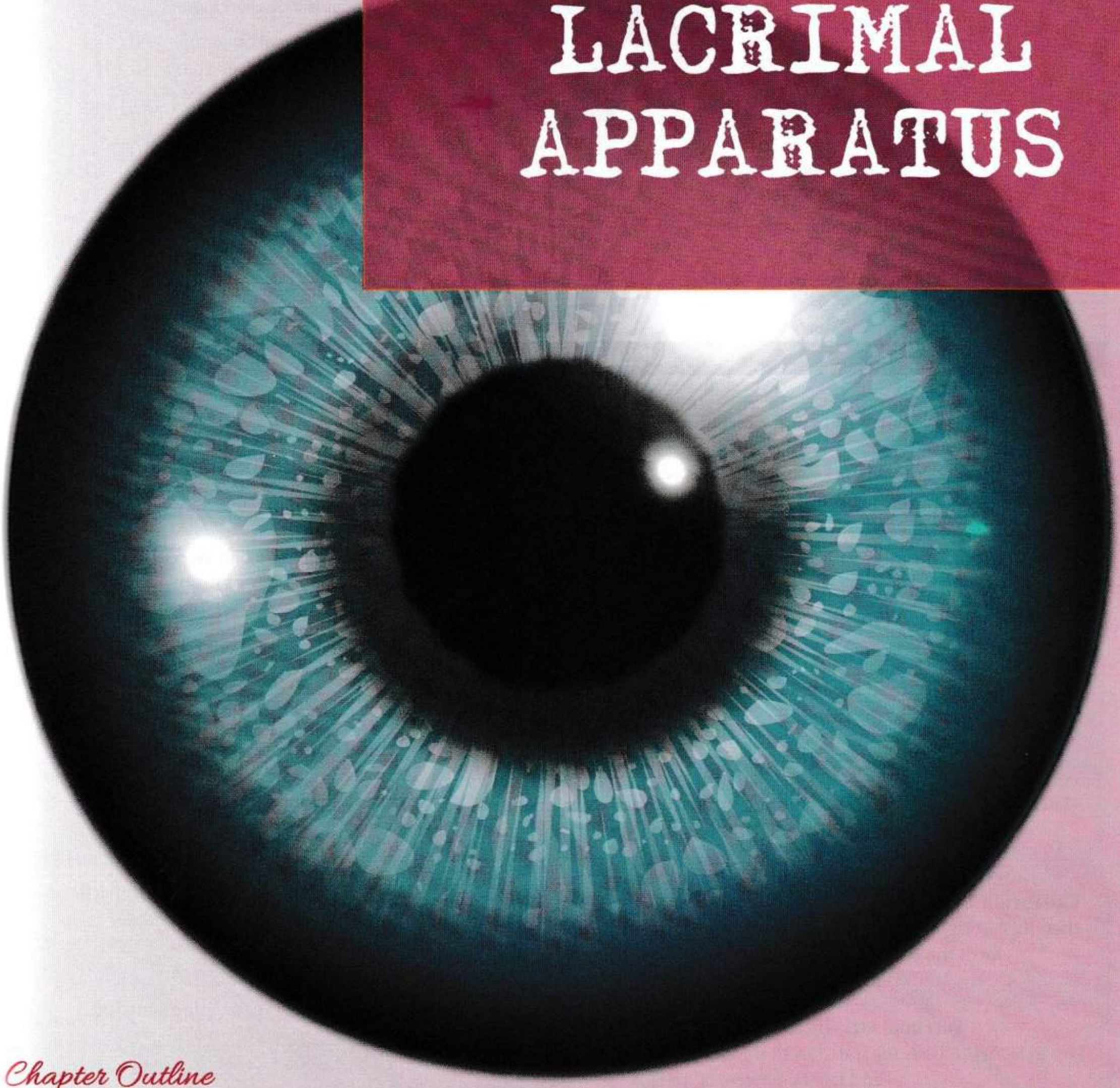
Ref: Yanoff 4/e, p. 489

DHA is the major component of the rod membranes. DHA levels have been found to be low in X linked retinitis pigmentosa.

But treatment with DHA doesnot statistically effect the course of visual loss.

9

LACRIMAL APPARATUS



Chapter Outline

Lacrimal Apparatus
- Anatomy
- Physiology

Watering Eye
- Tests
- Dacryocystitis

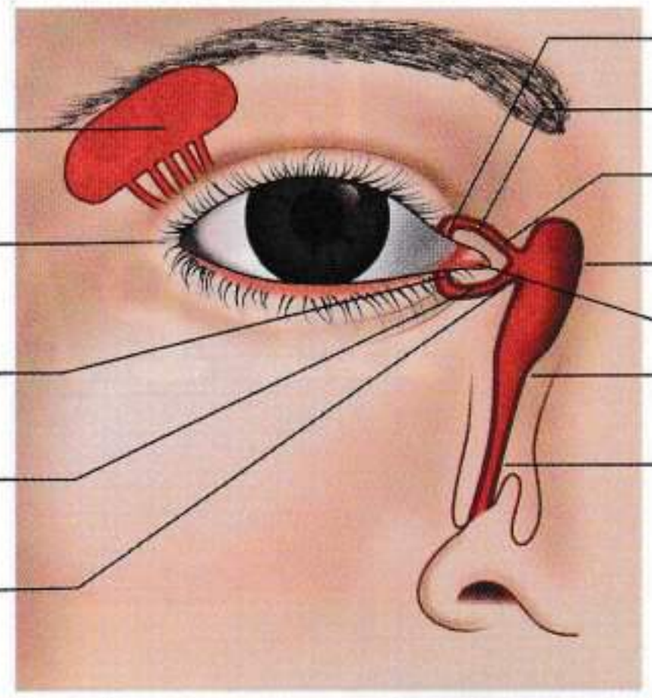
Tear Film
- Dry Eye
- Tests for Dry Eye

"Never a tear bedims the eye that time and patience will not dry."

—Bret Harte

LACRIMAL APPARATUS

Anatomy



Lacrimal apparatus

Formation and Secretion of Tears

- **Reflex secretion:** Main lacrimal gland - serous gland, situated at the upper and outer[Q] angle of orbit, divided into upper orbital part and lower palpebral part by aponeurosis of levator (LPS) fibers

and

- **Basal secretion:**[Q] Accessory lacrimal glands of Krause (42[Q] in upper fornix and 6–8 in lower fornix) and Wolfring

↓

Ducts open in the upper fornix (mainly) for secretion

↓

Lacrimal drainage apparatus consists of the following

Lacrimal Puncta: One in each eyelid, located at the posterior edge of lid margin, 6 mm from inner canthus

↓

Canaliculi: Upper and lower canaliculi are directed 1–2 mm vertically and then turn at right angle to become horizontal for ~8 mm, before joining to form the common canalicular duct which opens into the

↓

Lacrimal sac: Guarded by valve of Rosenmüller
Lies in lacrimal fossa, separated from middle meatus of nose by lacrimal bone and frontal process of maxilla

↓

Nasolacrimal duct (NLD) – directed downward, backward and laterally[Q]

↓

Opens in the **inferior meatus** of nasal cavity – guarded by the valve of Hasner

EXTRA MILE

- In dacryocystorhinostomy **(DCR)**, an anastomosis is created between lacrimal sac and nasal mucosa by removing the lacrimal bone to bypass the NLD
- All lacrimal gland ducts pass through the palpebral part of main lacrimal gland, thus its excision causes total loss of all secretory function
- Lacrimal sac is surrounded by fibers of orbicularis oculi muscle

Nerve supply of lacrimal gland – Parasympathetic (secretomotor)

Superior salivatory muscles

↓

Facial nerve and greater superficial petrosal nerve

↓

Pterygopalatine ganglion

↓

Zygomatic nerve and lacrimal nerve (branches of trigeminal nerve)

↓

Lacrimal gland

Physiology

Drainage of tears occurs mainly by capillarity and by suction—**Lacrimal Pump**

↓

On blinking, with closure of eyelids

↓

Horner's muscle contracts, compressing the common canalicular duct and pulling the lacrimal sac laterally

↓

Lacrimal sac dilates/open, creating a negative pressure drawing in tears from the canaliculi into the sac

↓

With opening of eyelids

↓

Relaxation of Horner's muscle leads to collapse of lacrimal sac pushing tears into the NLD

↓

Canaliculi also expand and being empty exert a negative pressure to draw in fluid

WATERING EYE

Overflow of tears from the conjunctival sac may be either

- **Hyperlacrimation**: Excessive secretion of tears due to ocular inflammation or surface ocular disease, emotional and psychiatric causes lacrimal gland diseases.
- **Epiphora**: Watering due to obstruction to outflow of tears (lacrimal canaliculi or NLD) or lacrimal pump failure or punctual malposition.

Tests for Evaluation of Watering Eye

Regurgitation Test

Pressure is applied over the lacrimal sac with thumb. Regurgitation of mucopurulent discharge from the punctum indicates NLD obstruction with chronic dacryocystitis.

Lacrimal Syringing, Probing and Jones dye Test

Lower Punctum is dilated with the help of a NETTLESHIP Punctum dilator

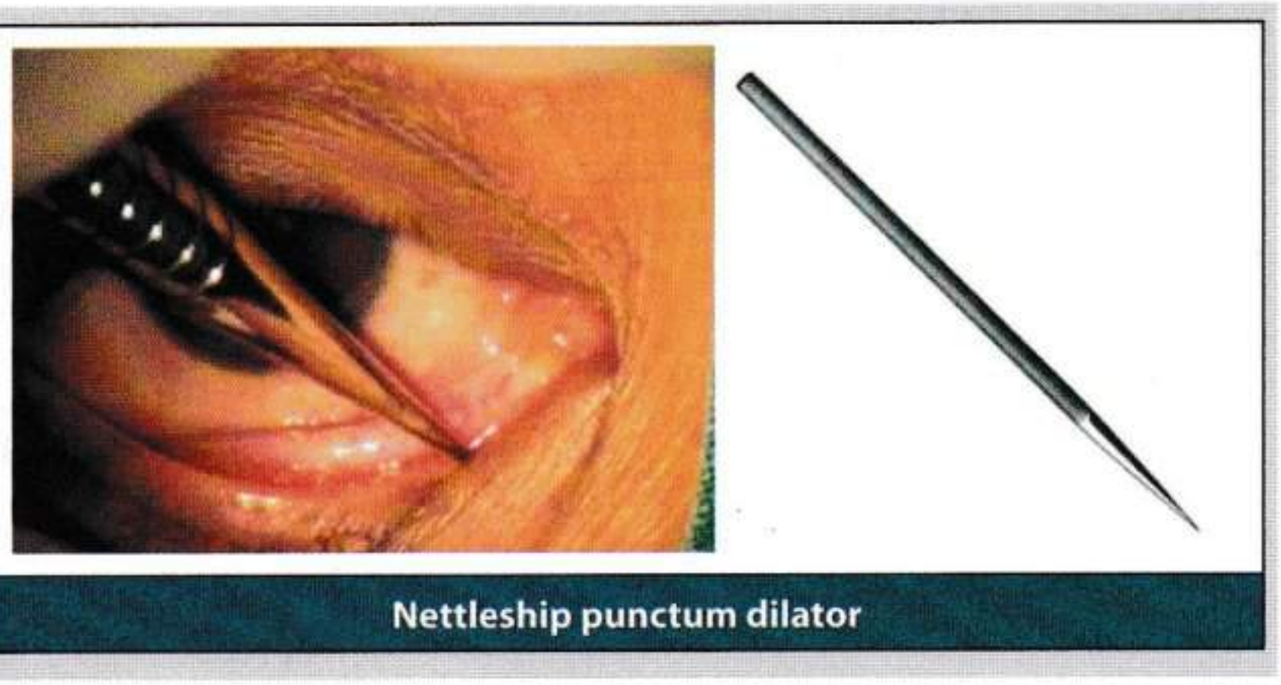
↓

Blunt tipped, curved 26 gauge cannula inserted into the punctum and the lower canaliculi

↓

Saline is injected for irrigation

↓



Nettleship punctum dilator

Fluid flows into the nasal cavity and throat

PATENT – lacrimal apparatus (No obstruction)

Cause of watering may be
- Hypersecretion or
- Lacrimal pump failure or
- Partial obstruction

Regurgitation of fluid

OBSTRUCTION is present in the lacrimal drainage

PROBING done by Bowman's lacrimal probe

Bowman's lacrimal probe

Probe comes to a **HARD STOP**

NLD block
(hard indicates probe entering lacrimal sac and hitting lacrimal bone)

Probe comes to a **SOFT STOP**

CANALICULAR BLOCK

5–8 mm from punctum

Lower or upper canalicular block

>8 mm from punctum

Common canalicular block

Jones Dye Test

Used in cases of partial obstruction where syringing is not conclusive (shows Patency)

Jones Dye Test 1

2% fluorescein dye is instilled into the conjunctival sac and after 5 minutes a cotton bud soaked in anesthetic is placed at the opening of NLD

Fluorescein staining seen on bud
POSITIVE TEST

PATENT drainage

Watering due to **hypersecretion**

No staining seen on bud
NEGATIVE TEST

Partial obstruction or lacrimal pump failure

Jones Dye test 2
Residual fluorescein is washed out by irrigation and bud placed

Fluorescein staining seen POSITIVE TEST

Partial obstruction of NLD

No staining seen NEGATIVE TEST

Lacrimal pump failure or partial obstruction of upper lacrimal pathway

EXTRA MILE

Site of obstruction			
Upper or lower canaliculi ↓ Regurgitation from same canaliculi (+) If partial block Jones test 1 and 2 negative	Common canaliculi ↓ Regurgitation from opposite punctum with SOFT stop (+) If partial block Jones test 1 and 2 negative	NLD blockage ↓ Regurgitation from opposite punctum after sometime with HARD stop	Partial NLD blockage ↓ Regurgitation from opposite punctum with some fluid in nasal cavity with HARD Stop (+) Test 1 negative and 2 positive
Treatment Conjunctivodacryocysto-rhinostomy (CDCR) with Jones tube	Canaliculodacryo-cystorhinostomy (CDCR) or Intubation with silicone stents if partial block	Dacryocystorhinostomy (DCR)	Pressure syringing with antibiotics
Functional blockage: Due to punctal phimosis, lacrimal pump failure has jones dye test 1 negative with jones dye test 2 negative with no regurgitation.			

Dacryocystography

Used **to diagnose functional blockage** and differentiate it from partial blockage by using a contrast medium such as lipiodol. A normal DCG with epiphora is suggestive for it.

Scintigraphy

More sensitive than DCG for assessing incomplete blocks and physiological (functional) obstruction.

Pathologies

Dacryocystitis

It is the inflammation of the lacrimal sac. It may be

Congenital Dacryocystitis	Adult Dacryocystitis

• Inflammation of the lacrimal sac in a newborn, **most commonly due to delayed/incomplete canalization of the NLD**[Q], most often at the lower and **near valve of Hasner**–occlusion is membranous[Q]
• Presents with epiphora, swelling and purulent discharge at inner canthus
• **Treatment**
  ▪ **Massage** over lacrimal sac[Q] with topical antibiotics[Q] —initial treatment of choice[Q]
  ▪ Syringing[Q] is attempted usually by 9–12 months of age
  ▪ Probing of NLD[Q] —should be undertaken after 12 months[Q] of age, as spontaneous resolution is likely to occur by 12 months[Q]
  ▪ DCR[Q] after 4 years of age
	Chronic
	• Stricture of nasal duct, which is usually complicated by **Pneumococcus**[Q]
	• Patient presents with painless swelling and epiphora
	• DCR[Q] is the treatment of choice
	Acute
	• Acute suppurative inflammation, with superimposed ***Streptococcus haemolyticus***[Q] infection
	• Abscess and fistula formation may occur
	• Treat with antibiotics (oral)[Q] or incision and drainage if pus points and abscess seen
	or
	DCR if fistula forms

Dacryops

Cystic swelling in upper fornix due to retention of secretions caused by lacrimal duct blockage.

Mikulicz Syndrome

Symmetrical enlargement of lacrimal and salivary glands, associated with diseases like TB, sarcoidosis, Hodgkin's disease

Tumors of Lacrimal Gland

- **Pleomorphic adenoma**—most common benign tumor[Q]
- Adenoid cystic carcinoma—worst prognosis. Presents with lateral, upper eyelid fullness, pushing the globe downward and inward. It is the most common malignant tumor

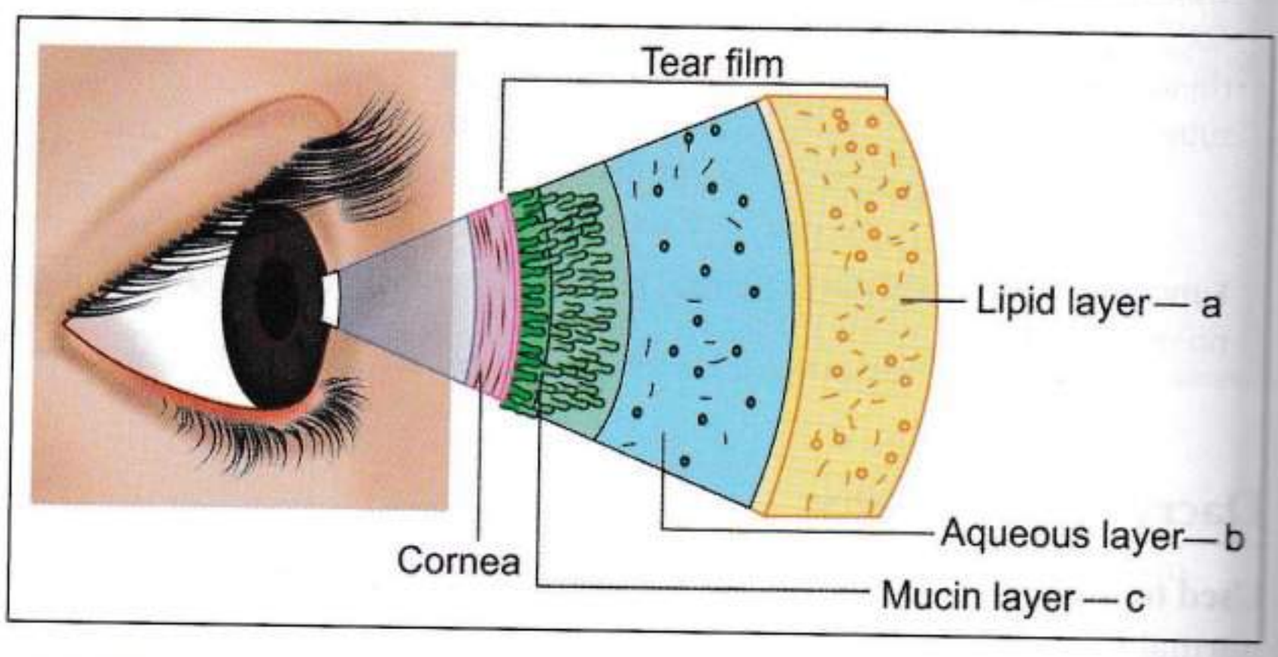
TEAR FILM

It is composed of **3 layers**

a. Secreted by **Meibomian** gland.
Retards evaporation and lubricates the eyelids

b. Secreted by **lacrimal** glands.
Supplies atmospheric O_2 to cornea and has antibacterial function

c. Secreted by **Goblet cells**
Converts hydrophobic corneal surface to hydrophilic



Dry Eye Disease

Dry eye is a multifactorial disease of the tears and ocular surface that results in symptoms of discomfort, visual disturbance and tear film instability with potential damage to the ocular surface. It is accompanied by increased osmolarity (activates/initiates the process) of the tear film and inflammation (perpetuates the process) of the ocular surface.

Classification

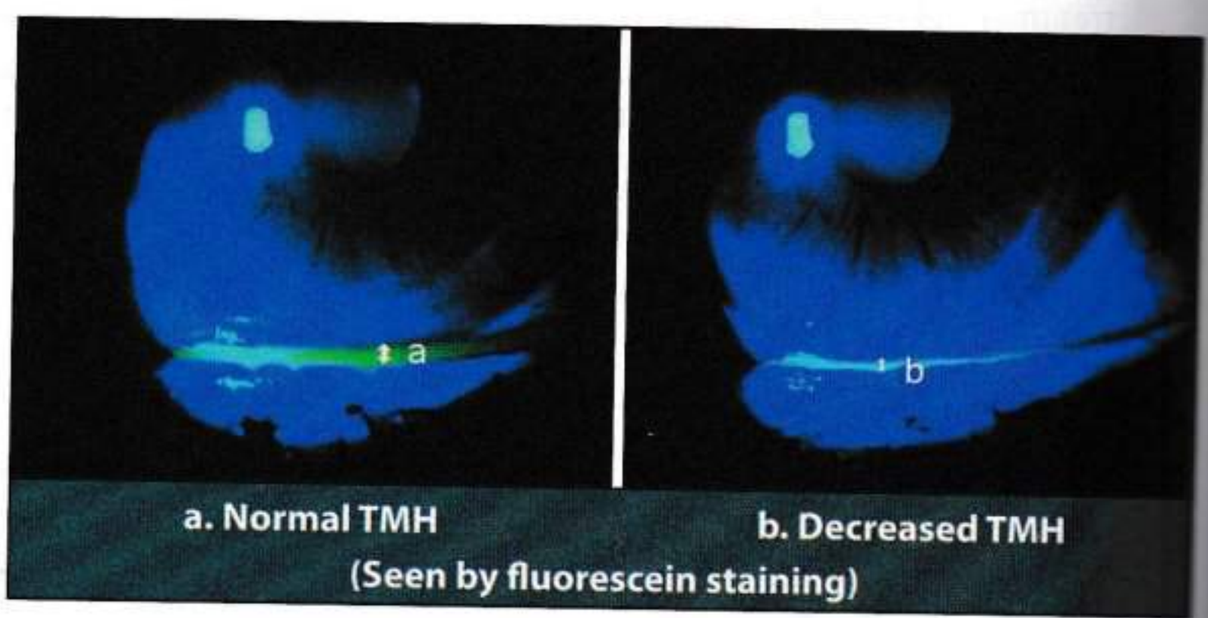
Holly and Lemp classified dry eye in 1977. It can be classified as follows

Aqueous deficiency	Lipid deficiency	Mucin deficiency
Keratoconjunctivitis sicca (KCS)	Evaporative	
Causes		
Sjögren's syndrome	Meibomian gland disease (MGD)	Vitamin A deficiency
Non-Sjögren's	Posterior blepharitis	Pemphigoid
Age-related hyposecretion	Rosacea	Stevens–Johnson syndrome
Congenital alacrima	Atopic keratoconjunctivitis	Chemical burns
Lacrimal gland disease	Low blink rate (Bell's palsy)	Trachoma
Riley day syndrome	Contact lens wear	

Clinical Features

Symptoms

- Foreign body sensation
- Grittiness/Irritation
- Burning sensation characteristically worse at night
- Associated with itching, blurred vision, photophobia, discomfort



a. Normal TMH **b. Decreased TMH**
(Seen by fluorescein staining)

Signs

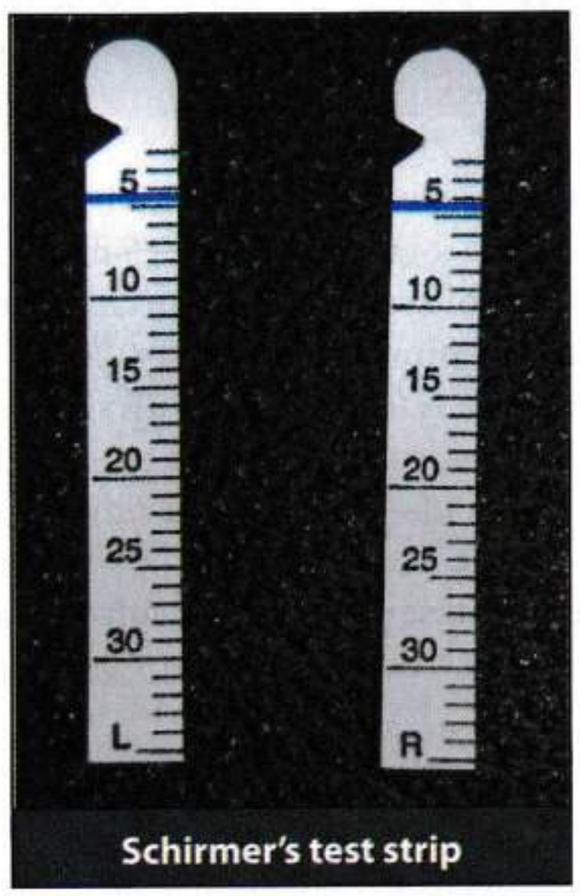
Tear film	• Decrease of tear meniscus height (TMH) < 0.5 mm • Debris in tear film–moves with each blink
Lid and Conjunctiva	• Lack of luster–Conjunctival/corneal surface • Hyperemia, keratinization of conjunctiva • Frothy discharge at lid margins • Meibomian gland disease or posterior blepharitis
Cornea	• Punctate epithelial erosions • Filaments

Tests

Schirmer Test

- A quantitative test—Tests aqueous tear production
- Uses Whatman filter paper No. 41, 5 mm wide and 35 mm long, inserted in the lower fornix
- **Schirmer I** – Performed without an anesthetic – measures maximum basal and reflex tear secretion. Read after 5 minutes
  - > 15 mm – normal
  - < 10 mm – suggestive of dry eye
- **Schirmer II** – Tests reflex secretion

Schirmer's test



Schirmer's test strip

Tear film break up time (TBUT)

2% fluorescein is instilled in the lower fornix and examined in cobalt blue light

↓

Patient is asked to blink several times

↓

TBUT—interval between the last blink and the appearance of the first randomly distributed dry spot on cornea

↓

TBUT < 10 seconds	Dry spot always in same location
↓	↓
Suggests MUCIN deficiency	Corneal surface abnormality

Ocular Surface Staining

- **Fluorescein staining**—2% fluorescein (water soluble) stains cŏrneal and conjunctival epithelium where there is break in epithelium. Produces green fluorescent color in alkaline tears
- **Rose bengal staining**—1% solution, stains devitalized cells, filaments and plaques

Other Tests

- Conjunctival impression cytology
- Tear function index (TFI)—a quotient of Schirmer test and Tear clearance rate
- Lactoferrin levels—decreased in Sjögren's syndrome
- **Phenol red thread test**[Q] —uses a thread impregnated with phenol red dye, which changes color from yellow to red in tears. < 6 mm value is abnormal after 15 seconds.
- Tear lysozyme levels—decreased
- **Tear meniscus height**—< 0.5 mm is abnormal

Treatment

- **Tear substitutes**—preferably preservative free
  - Carboxymethyl cellulose (CMC)—for retention
  - Hydroxypropyl methyl cellulose (HPMC)—for wettability
  - Polyvinylalcohol (PVA)—in mucin deficiency
  - Hydroxypropyl guar and sodium hyaluronate in dry eye with punctate corneal epithelial erosions
  - Glycol, PEG, Propylene glycol
- **Punctal plugs**—reduce drainage and thus preserve natural tears
- **Tear stimulants**—oral pilocarpine (5 mg TDS), oral cevimeline (10 mg BD), in patients with Sjögren's syndrome
- **Serum drops**—for severe ocular surface disorder, prepared from patient's blood
- **Topical anti-inflammatory therapy**
  - Cyclosporine A 0.05% p. 1%—**first-line therapy in secondary Sjögren's syndrome** and inflammatory origin dry eye
  - Steroids (low dose)—for acute exacerbations
- **Omega-3 fatty acids**—useful as an Adjunct in MGD and rosacea
- **Oral Tetracycline**—for MGD
- **Tarsorrhaphy**—in severe dry eye with nonhealing defects and thinning
- **Mucolytic agents**—acetylcysteine (5% drops) if corneal filaments and mucous plaques are present.

IMAGE-BASED QUESTIONS

1. The given instrument is used in which of the following

Image 1

a. Dacryocystorhinostomy
b. Probing and irrigation
c. Enucleation
d. Exentration

2. Identify the valve present at no.6 as marked in this picture

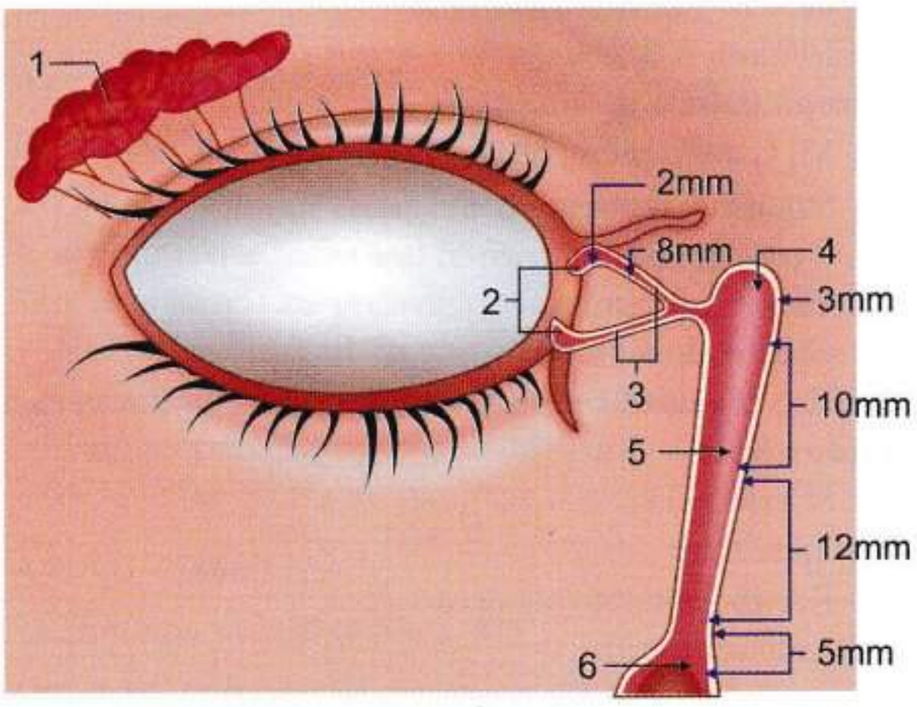


Image 2

a. Valve of Hasner
b. Rosenmuller
c. Valve of krause
d. None of the above

3. The test shown in the picture is for

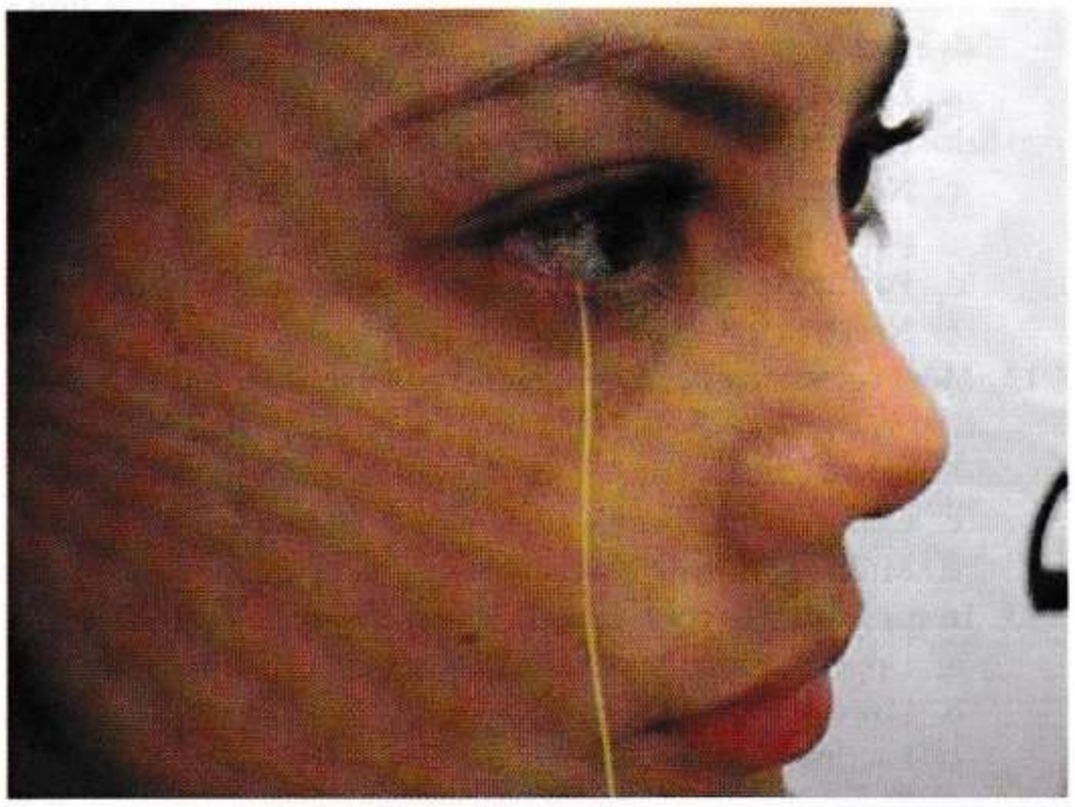


Image 3

a. Amount of tear secretion
b. Quality of tear
c. To assess the mucin content
d. To assess the lipid layer of tears

MULTIPLE CHOICE QUESTIONS

4. Valve of rosenmuller is present in which part of lacrimal system? *(Recent pattern 2014)*
a. Puncta
b. Canaliculi
c. Lacrimal sac
d. Nasolacrimal duct

5. About Nasolacrimal duct, which is not true
a. It is a serous duct *(Recent pattern Nov/Dec 2016)*
b. It functions as a Mucosa associated lymphoid tissue
c. It drains tears into the inferior meatus of the nose
d. It is lined by fibres of Horner muscle

6. What is the anatomical relation of the upper lacrimal punctum with respect to lower punctum *(DNB 2012)*
a. Medial
b. Lateral
c. Apposed
d. No relation

7. Causes of epiphora: *(PGI Nov 2013)*
a. Nasolacrimal duct obstruction
b. Facial nerve palsy
c. Allergic conjunctivitis
d. Lower ectropion

8. Probing and irrigation is not done in:
a. Lacrimal fistula *(Recent pattern Nov/Dec 2016)*
b. Acute dacryocystitis
c. Congenital dacryocystitis
d. Trauma to eye

9. A 60 year old man presented with watering from the left eye since one year. Syringing revealed a patent drainage system. Rest of the ocular examination was normal. A provisional diagnosis of lacrimal pump failure was made. Confirmation of the diagnosis can be done by *(AIIMS Nov 2002)*
a. Dacryoscintigraphy
b. Dacryocystography
c. Pressure Syringing
d. Canalicular irrigation test

10. Negative Jones-1 and jones-II Dye test indicate *(Recent pattern Question 2016)*

a. Primary Hypersecretion of tears
b. Partial obstruction of distal nasolacrimal duct
c. Lacrimal pump failure
d. Partial obstruction of lacrimal canaliculi

11. Which of the following statement(s) is/are true about Jones dye test: *(PGI Nov 2015)*

a. Done for assessment of epiphora
b. Positive test-1: primary hypersecretion
c. Negative test-1: partial obstruction or failure of lacrimal pump mechanism
d. Positive test-2: failure of lacrimal pump mechanism
e. Negative test-2: partial obstruction

12. Most common site of congenital nasolacrimal duct obstruction is *(PGI May 2013)*

a. Upper canaliculus b. Lower canalicus
c. Common canaliculus d. Valve of Hasner
e. Middle turbinate near canthus

13. In congenital darcryocystitis which structure is blocked?

a. Upper lacrimal puncta *(DNB 2012)*
b. Lower lacrimal puncta
c. Lacrimal canaliculi
d. Nasolacrimal duct

14. Dacryocystorhinostomy involves: *(Recent pattern Nov/Dec 2016)*

a. Opening up the terminal blocked end of nasolacrimal duct
b. Connecting the lacrimal sac to nose by breaking the medial wall
c. Complete excision of lacrimal
d. Insertion of drainage tube in the lacrimal sac

15. What is the initial management of congenital dacryocystitis? *(Recent pattern 2014)*

a. Massage
b. Lacrimal syringing
c. Dacryocystorhinostomy
d. Antibiotics

16. All are true regarding tear film except: *(PGI Nov 2011)*

a. Consists of aqueous, lipid & mucus layer
b. Lipid layer is secreted by meibomian glands
c. Aqueous layer is formed by filtration from blood capillaries
d. Deficiency cause dry eye
e. Protects the cornea from dryness

17. Mucin tear film deficiency occurs in *(AIIMS May 2006)*

a. Keratoconjunctivitis sicca
b. Lacrimal gland removal
c. Canalicular block
d. Herpetic keratitis

18. Goblet cells are seen in

a. Epithelium of Cornea
b. Epithelium of Conjunctiva
c. Stroma of conjunctiva
d. Bowman layer of cornea

19. Schirmer's test detects abnormality of which nerve:

a. Oculomotor *(Recent pattern Nov 2015)*
b. Facial
c. Hypoglossal
d. Glossopharyngeal

20. Phenol red thread test dry eye, true is *(AIIMS May 2016)*

a. Colour change on contact with tears to assess the volume of tears
b. Uses a pH meter for measurement and interpretation
c. Measures ocular surface mucin deficiency if thread colour changes to blue
d. Requires instillation of topical anesthesia before the procedure

21. Xerostomia, Xerophthalmia area part of

a. Sjogren syndrome *(Recent pattern Nov 2016)*
b. Riley day syndrome
c. Stevens-Johnson syndrome
d. Vitamin A deficiency

22. Xerophthalmia is caused by:

a. Vit C deficiency
b. Small bowel resection
c. Cystic fibrosis
d. Chronic alcoholism
e. Glomerulonephritis

23. What is the most common ocular manifestation in rheumatoid arthritis?

a. Scleritis
b. Episcleritis
c. Keratoconjunctivitis sicca
d. Anterior uveitis

24. Pleomorphic adenoma of the lacrimal gland moves the eyeball: *(Recent pattern Dec 2015)*

a. Downwards and outwards
b. Downwards and inwards
c. Upwards and outwards
d. Upwards and inwards

25. Crocodile tears are seen in: *(AIIMS India Dec 2014)*

a. Frey's Syndrome
b. Conjunctivitis
c. Lacrimal tumour
d. Abnormal VII nerve regeneration

ANSWERS TO IMAGE-BASED QUESTIONS

1. Ans. (a) Dacryocystorhinostomy

Ref: Yanoff and Duker, 4/e, p. 1486

The nose is entered by pushing the instrument through the suture line between the lacrimal bone and the frontal process of the maxilla. **Kerrison punches** are used to remove the bone between the sac fossa and the nose.

2. Ans. (a) Valve of Hasner

Ref: Parson's 22/e, p. 473

Valve of Hasner present at the lower end of NLD. Valve present at the junction of common canaliculus and sac is valve of Rosenmuller.

3. Ans. (a) Amount of tear secretion

Ref: Kanski 7/e, p. 128

Test shown is phenol thread test to identify the quantity of tear secretion.

ANSWERS TO MULTIPLE CHOICE QUESTIONS

4. Ans. (b) Canaliculi

Ref: Parson's 20/e, p. 445

A small flap of mucosa (**valve of rosenmuller**) overhangs the junction of the common canaliculus and the lacrimal sac and **prevents reflux of tears into the canaliculi**.

5. Ans. (d) It is lined by fibres of Horner muscle

Ref: Ocular surface disorders, Lemp p. 7

- Upper and lower canaliculi are surrounded by a dense ring of connective tissue and fibres of the Horner muscle
- Serous glands are present in the lamina propria of the ducts
- NLD's are integral to the ocular immune system. They consist of T lymphocytes and CD20, CD45RA rich B lymphocytes. Aggregated follicles are present in nearly one third of the NLD's fulfilling the criteria for MALT

6. Ans. (a) Medial

Ref: Khurana Anatomy 2/e, p. 375

The upper punctum lies 0.5mm medial to the lower punctum. Upper punctum is directed downwards and backwards while the lower punctum is directed upwards and backwards.

7. Ans. (a) Nasolac…., (b) Facial…., (d) Lower….

Ref: Pediatrics and Ophthalmology by Hoyt and Taylor 4/e, p. 172

- Allergic conjunctivitis - ocular inflammation causes hyperlacrimation
- 7th CN palsy—epiphora occurs as orbicularis muscle palsy occurs leading to functional blockage — epiphora due to lacrimal pump failure.
- Punctal malposition (due to ectropion) and NLD block also cause epiphora

8. Ans. (b) Acute Dacryocystitis

Ref Parson's 21/e p. 464, 466

Contraindications to Probing and Irrigation

- The main Contraindications are Acute Dacryocystitis and Acute canaliculitis.

In the setting of active infection, probing and irrigation are most likely to cause trauma because the lacrimal sac wall is inflated and friable, it also can cause unnecessary pain and anxiety for the patient.

9. Ans. (a) Dacryoscintigraphy

Ref: Revision lacrimal surgery 2/e, p. 375

Following **tests** are available for evaluation of **epiphora**:

- **For mechanical obstruction** – Regurgitation test, fluorescein dye test, lacrimal syringing test, Jones dye test, dacryocystography.
- **For functional (physiological) obstruction due to lacrimal pump failure**- Dacryoscintigraphy or radionucleotide Dacryocystography (more sensitive), Fluorescein dye disappearance test.

10. Ans. (c) Lacrimal pump failure

Ref: Kanski 8/e, p. 67, 68

- Partial obstruction of proximal lacrimal passages (Punctal or canalicular) or pump failure– Negative Jones 2
- Partial obstruction of the nasolacrimal duct distal to the sac–Positive Jones, 2.

11. Ans. (a) Done for as..., (b) Positive test-1..., (c) Negative... (e) Negative test-2: …

Ref: Khurana Anatomy and Physiology 2/e, p. 395 Kanski 7/e, p. 70; Parson's 22/e, p. 478

12. Ans. (d) Valve of Hasner

Ref: Parson's 20/e, p. 444-46

Refer text

13. Ans. (d) Nasolacrimal duct

Ref: Parson's 20/e, p. 447

14. Ans. (b) Connecting the lacrimal sac to nose by breaking the medial wall

Ref: Kanski 7/e, p. 74

15. Ans. (a) Massage

Ref: Kanski 7/e, p. 72-73

16. Ans. (c) Aqueous layer...

Ref: Khurana 4/e, p. 354-66; Parson's 20/e, p. 156

Aqueous layer - The bulk of tear film is formed by this intermediate layer which consists of tears secreted by the *main and accessory lacrimal glands.* it is alkaline and salty in taste. It also *contains antibacterial substances* like lysozyme, betalysin and lactoferrin.

17. Ans. (d) Herpetic keratitis

Ref: Khurana anatomy, 2/e, p. 389

Soluble surfactant (Mucin) deficiency is caused by ocular surface disorders affecting the goblet cells which secrete mucus forming the innermost layer of the tear film. Herpes infection ccauses Keratoconjunctivitis and hence mucin deficiency.

18. Ans. (b) Epithelium of Conjunctiva

Ref: Khurana Anatomy, 2/e, p. 368

19. Ans. (b) Facial

Ref: Oxford Handbook of Otolaryngology

Topographic testing of the facial nerve palsy – Schirmer's test evaluates the function of the greater superficial petrosal nerve, branch of facial nerve. It compares tear production of involved and uninvolved eye.

20. Ans. (a) Colour change on contact with tears to assess the volume of tears

Ref: Yanoff 4/e, p. 277

Phenol red thread test was developed by Hamano et al to obviate the disadvantages of Schirmer's test by eliminating the need for anaesthesia.

3 mm. of fine dye-impregnated 75mm cotton thread is placed in the lateral one-fifth of the inferior palpebral lid margin for 15 seconds, alkalinity changes its color bright orange to red from tear contact.

21. Ans. (a) Sjogren syndrome

Ref: Kanski 7/e, p. 124-126

Sjogren syndrome is characterized by autoimmune inflammation and destruction of lacrimal and salivary glands – thus causing dryness of mouth and Xerosis or xerophthalmia.

22. Ans. (b) Small.., (c) Cystic.. & (d) Chronic..

Ref: Khurana 4/e, p. 433-34; Parson's 20/e, p. 93

"Absorption of water soluble & fat soluble vitamins (including Vit A) except B_{12} takes place in upper & mid small intestine"-Ganong 23/e, p. 452, Thus option B and C

Option D - interference with absorption of Vit A.

23. Ans. (c) Keratoconjunctivitis sicca

Ref: Smolin and Thoft's The cornea, 4/e, p. 517

- MC systemic association of episcleritis is Rheumatoid arthritis

24. Ans. (b) Downwards and inwards

Ref: Khurana 6/e, p. 399

Benign mixed tumour of lacrimal gland

- It is also known as **pleomorphic adenoma** and occurs predominantly in young adult males.
- Clinically it presents as a slowly progressive **painless** swelling in the upper – outer quadrant of the orbit displacing the eyeball **downwards and inwards**.
- It is **locally invasive** and infiltrate its own pseudocapsule to involve the adjacent periosteum.
- Histologically, it is characterized by the presence of pleomorphic myxomatous tissue, just like benign mixed tumour of salivary gland.
- Treatment consists of **complete surgical removal with the capsule**. Recurrences are very common following incomplete removal.

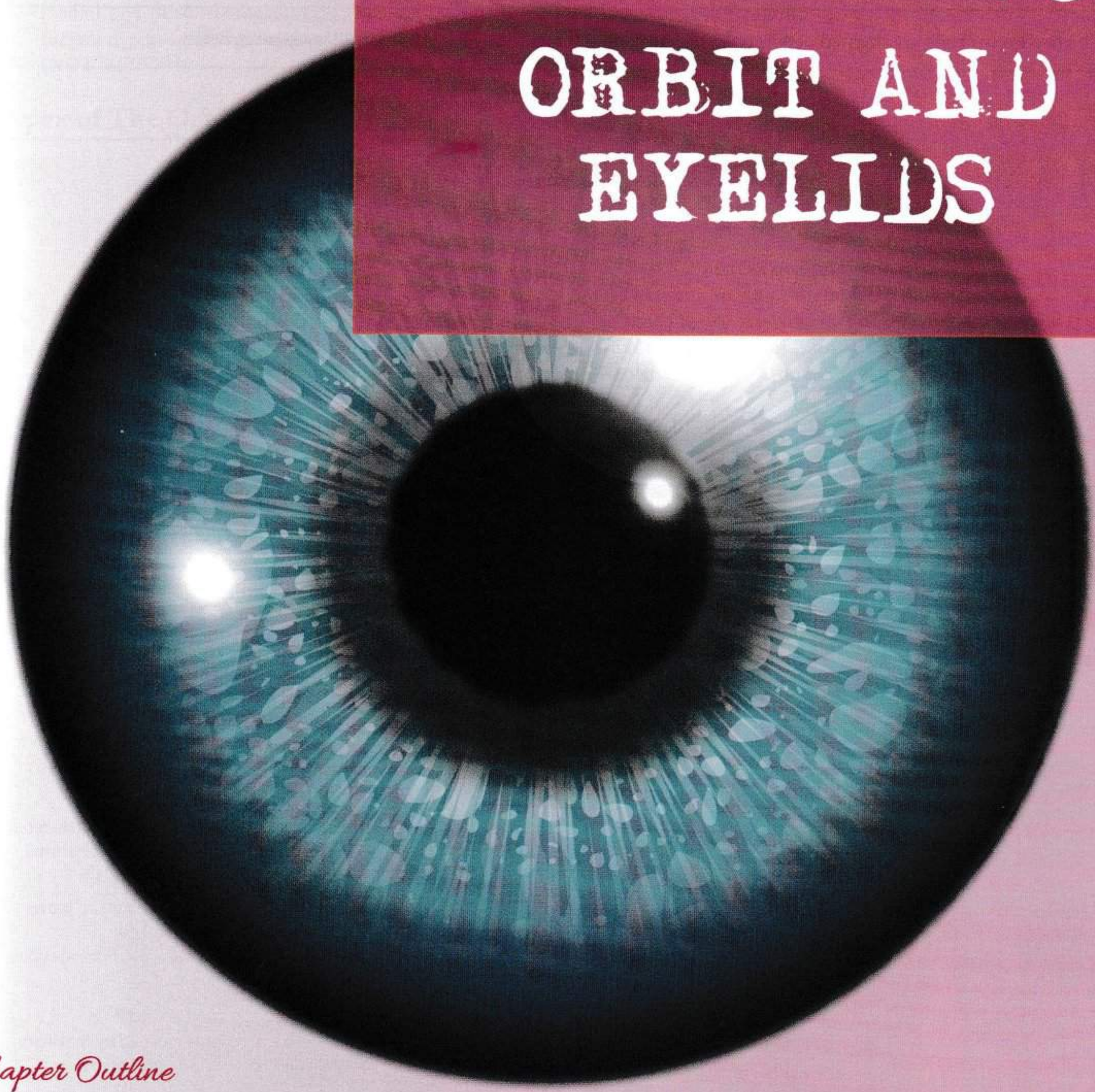
25. Ans. (d) Abnormal VII nerve regeneration

Ref P L Dhingra p. 103

- Crocodile tears are seen in Abnormal regeneration of 7th nerve
- It is one of the complication following facial nerve palsy. It is characterized by unilateral lacrimation with mastication and is due to faulty regeneration of parasympathetic fibres which now supply lacrimal gland instead of salivary glands.

10

ORBIT AND EYELIDS



Chapter Outline

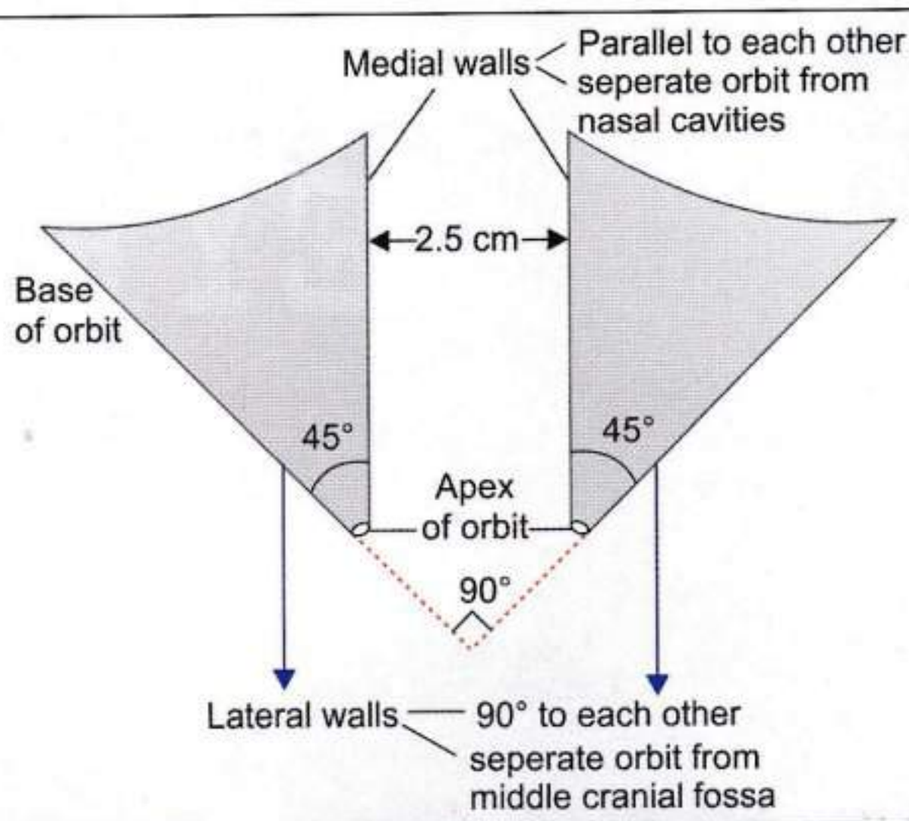
Anatomy
- Walls of the Orbit
- Base of the Orbit
- Apex of the Orbit

Proptosis
- Causes of Proptosis
  - Intermittent Proptosis
  - Pulsatile Proptosis
  - Pseudoproptosis
  - Vascular causes of Proptosis
  - Inflammatory causes of Proptosis
  - Neoplastic causes of Proptosis
- Thyroid Associated Ophthalmopathy (TAO)
  - Pathogenesis
  - Clinical Features
  - Treatment
- Eyelids
  - Anatomy
  - Muscles
  - Glands
- Inflammatory Lesions
- Entropion
- Ectropion
- Ptosis
- Disorders of Eyelash
- Tumors of Eyelids

ORBIT

ANATOMY

The two bony orbits are situated between the anterior cranial fossa above and the maxillary sinuses below



Transverse section (schematic) of the orbit

Walls of the Orbit

	Shape	Formed by	Description	Clinical relations
Medial wall	Quadrangular	• Frontal process of maxilla • Lacrimal bone (A3) • Orbital plate of ethmoid (A2) • Body of sphenoid[Q]	• **Medial to it** lie the anterior **ethmoidal air sinuses** • Anterior part contains lacrimal sac fossa and nasolacrimal canal (B4, B5)	**THINNEST[Q] wall of orbit** (lamina papyracea) ↓ Perforated by various nerves and vessels ↓ Thus, **ethmoiditis** is the **most common cause of orbital cellulitis[Q]**
Floor	Triangular	• Orbital plate of maxilla (A7) • Orbital surface of zygomatic • Palatine[Q]	Seperated from lateral wall by the **inferior orbital fissure**, infraorbital groove, infraorbital foramen (B9, B10, B6) ↓ **Infraorbital foramen** transmits infraorbital nerve[Q], artery[Q] and vein[Q]	• May be involved in **'blow-out' fractures[Q]** • It forms roof of the maxillary sinus ↓ Easily invaded by maxillary carcinoma ↓ Globe displaced upward
Lateral wall	Triangular	• Zygomatic bone (A6) • Greater wing of sphenoid[Q] (A5)	Lateral rim of orbit (forward extension of lateral wall) is the STRONGEST portion of orbit	Anterior half of globe is vulnerable to trauma as it protrudes beyond the lateral orbital margin
Roof	Triangular	• Orbital plate of frontal bone (A4) • Lesser wing of sphenoid[Q] (A1)	Separated from lateral wall by superior orbital fissure	Defect in roof may cause pulsatile proptosis

Base of The Orbit

Anterior open end of the orbit, bounded by orbital margins

- Superior orbital margin – sharp lateral two-thirds, round medial one-third. At the junction lies the **supraorbital foramen transmitting supraorbital nerve and artery (NOT VEIN)**[Q]
- Lateral orbital margin – the strongest
- Inferior orbital margin
- Medial orbital margin

Apex of The Orbit

Posterior end of the orbit, containing two orifices

OPTIC canal (B7)

- Lies between roof and medial wall[Q]
- Formed by[Q] lesser wing and greater wing of sphenoid
- **Transmits**[Q] optic nerve[Q] and the ophthalmic artery[Q]

SUPERIOR orbital fissure (B8)[Q]

- Lies between roof and lateral wall[Q]
- Bounded between lesser and greater wing of sphenoid
- Divided by annulus of Zinn into 3 parts
- Transmits 3rd/4th/5th (ophthalmic)/6th nerve

Upper part (above the annulus)

Lacrimal nerve[Q]
Frontal nerve[Q]
(both branches of ophthalmic division of trigeminal nerve)
Trochlear (IV)[Q] nerve
Superior ophthalmic vein
Recurrent branch of ophthalmic artery

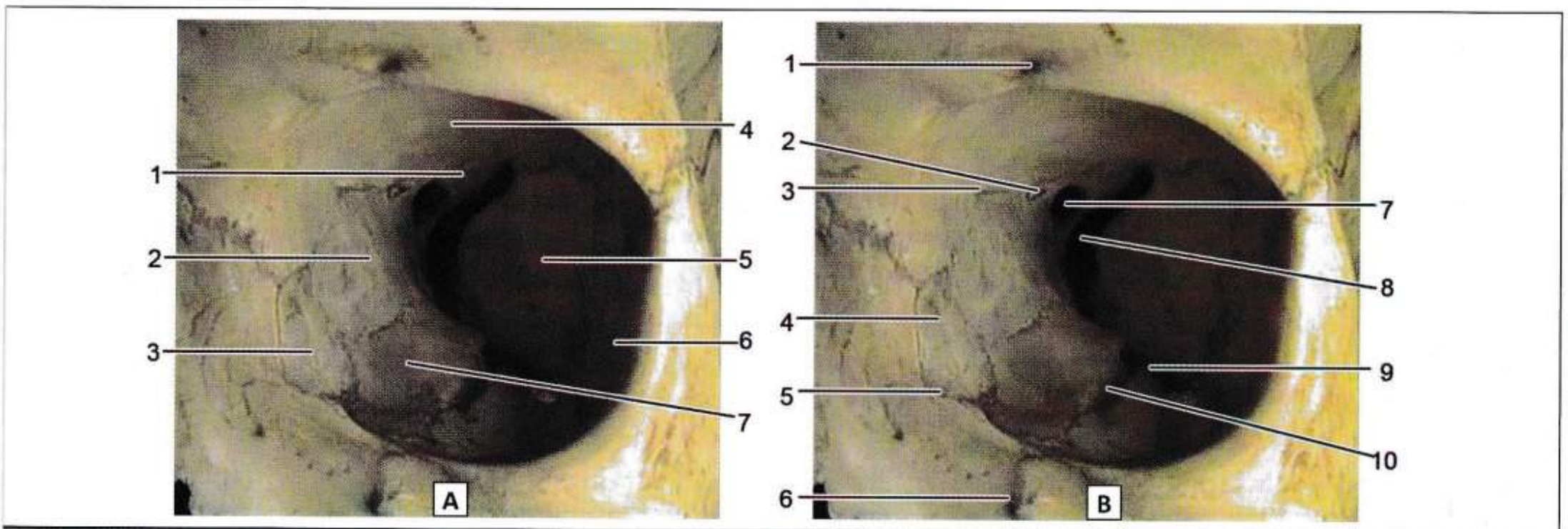
Middle part (within annulus)

Oculomotor (III)[Q] nerve – superior and inferior branches
Abducens (VI) nerve[Q]
Nasociliary nerve[Q] (branch of ophthalmic division of trigeminal nerve)

Lower part (below the annulus)

Inferior ophthalmic vein

Inferior orbital fissure lies between floor and lateral wall, formed by greater wing of sphenoid and maxilla **transmitting Maxillary nerve, Infraorbital vein and branches of pterygopalatine ganglion.**



Anterior view of the left orbit indicating the bones forming the walls (A) and the principal apertures (B)

A, 1. Lesser wing of sphenoid; 2. Orbital plate of ethmoid; 3. Lacrimal bone; 4. Orbital plate of frontal bone; 5. Greater wing of sphenoid; 6. Zygomatic; 7. Orbital plate of maxilla. **B,** 1. Supraorbital foramen; 2. Posterior ethmoidal foramen; 3. Anterior ethmoidal foramen; 4. Lacrimal fossa; 5. (Canal for) Nasolacrimal duct; 6. Infraorbital foramen; 7. Optic canal; 8. Superior orbital fissure; 9. Inferior orbital fissure; 10. Infraorbital groove.

Extra Mile

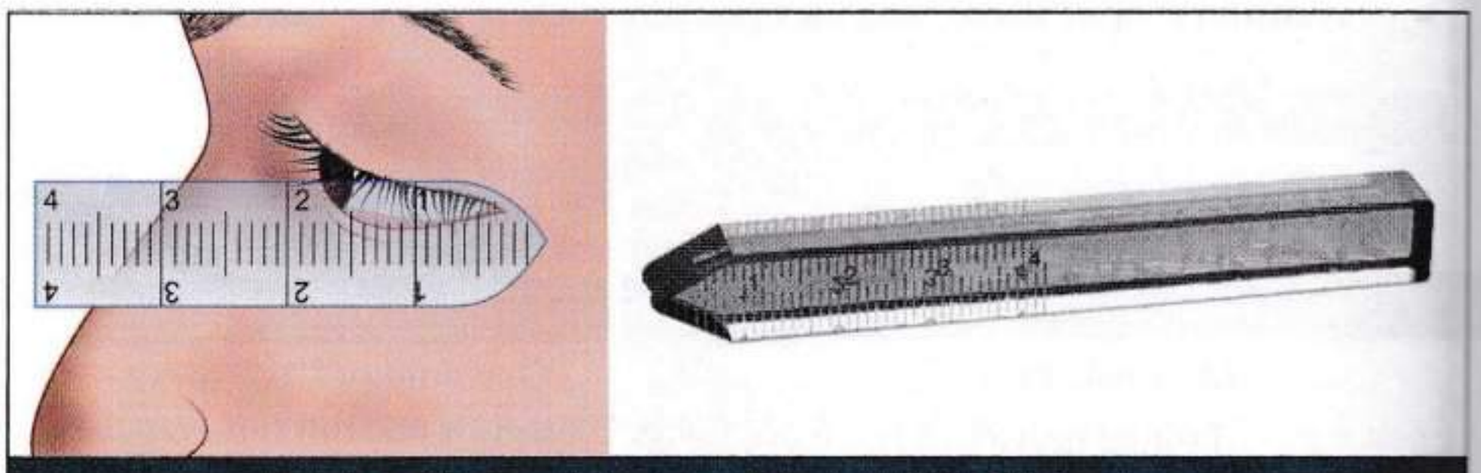
- **Periorbita** – periosteum lining the surface of the orbital bones. It is firmly adherent to[Q] the orbital margin, superior and inferior orbital fissures, optic canal, lacrimal fossa and the sutures.
- Fascia bulbi or **TENON's capsule** – envelopes globe from limbus to the optic disc.
- **Suspensory ligament of Lockwood** – lower part of Tenon's capsule is thickened, forming a sling or hammock on which the eyeball rests.

PROPTOSIS

Forward displacement of the globe (Protrusion) relative to the orbital rims is known as proptosis.
Protrusion is measured as the distance from the lateral orbital rim to the anterior corneal surface.
Normally, 14 mm to 21 mm
If >21 mm or >2 mm difference between two eyes – indicates proptosis.

It can be measured by

Hertel exophthalmometer



Luedde exophthalmometer (used in children)

Causes of Proptosis

Unilateral		Bilateral
AXIAL (Protrusion along the AP axis)	**ABAXIAL (Protrusion off the AP axis)**	
Painful	**Painful**	**Painful**
• Orbital hemorrhage	• Lacrimal gland tumor	• Cavernous sinus thrombosis
• Orbital cellulitis	• Nasopharyngeal carcinoma	• Grave's disease
• Cavernous sinus thrombosis	• Metastatic tumors	
Painless	**Painless**	**Painless**
• Intraconal Cavernous hemangioma	• Dermoid cyst, **Lacrimal gland tumors – downward and medial displacement of globe**[Q]	• Grave's disease
• Optic nerve glioma, meningioma	• Lymphoma, Maxillary sinus tumor – upward displacement of globe	• Caroticocavernous fistula
	• Ethmoid mucocele, Lacrimal sac tumors – lateral displacement of globe	• Pseudotumor

Intermittent Proptosis

- Proptosis that increases on bending forward or with Valsalva manoeuvre – **Orbital varices**[Q]
- Proptosis exacerbated with upper respiratory tract infection – **Orbital lymphangiomas**
- Increased proptosis on straining or crying – **capillary hemangiomas (children) or encephalocoele (infants)**

Pulsatile Proptosis

- **Caroticocavernous fistula**[Q]
- Bony defects in the orbital Roof, in patients with Neurofibromatosis Type I, Meningocele and trauma[Q]

Pseudoproptosis

- **Most common cause:** Retraction of eyelid in Grave's ophthalmopathy
- Contralateral eyelid ptosis
- **Enophthalmos (sunken eyeball):** Associated with microphthalmos, blow-out fracture of orbit[Q]
- Axial high myopia
- Idiosyncrasy in obese people
- Buphthalmos (congenital glaucoma)[Q]
- Stimulation of müller muscle by cocaine
- Shallow orbit in craniofacial dysostosis

Pseudoproptosis

(RE) lid retraction in Graves diseases gives false appearance of proptosis

HIGH YIELD

Most common cause of PROPTOSIS[Q]

	Adult	Children
Unilateral	Thyroid associated ophthalmopathy (Grave's disease)[Q]	Orbital cellulitis[Q]
Bilateral	Thyroid associated ophthalmopathy (Grave's disease)[Q]	Leukemia/AML (chloroma) and neuroblastoma[Q]

Vascular Causes of Proptosis

Feature	Orbital varices	Caroticocavernous fistula (Direct)
Pathology/Pathogenesis	Congenital enlargement of the pre-existing venous channels resulting from weakened orbital venous system	Results from an AV fistula between carotid artery and cavernous sinus usually after head injury
Age of presentation	Early childhood to late middle age	• **Traumatic**[Q]**:** Any age (days or weeks after head injury) – 75% cases • Spontaneous: Adults/Elderly
	Unilateral[Q] (most cases) are present nasally	Bilateral, but begins unilaterally
Pulsatile	Non pulsatile[Q]	Pulsatile[Q]
Compressible	Compressible[Q]	—
Bruit and Thrill	No Bruit/No Thrill[Q]	Bruit and Thrill present – which may be abolished by pressing on the ipsilateral carotid artery
Precipitating factor	As the orbital veins are devoid of valves rapidly reversible proptosis may be precipitated by valsalva manoeuvre and on bending forward (intermittent proptosis)[Q]	
MRI/CT	Show phleboliths (Echogenic shadows)	Prominence of superior ophthalmic vein and diffuse enlargement of extraocular muscles
Other clinical features	• Bag of worm consistency • Patients may develop acute orbital hemorrhage or thrombosis	**Severe ipsilateral headache** • Ophthalmoplegia – 3rd, 4th, 6th (most common)[Q] cranial nerve palsy • Dilated tortuous episcleral veins leading to raised IOP • Orbital and conjunctival congestion with chemosis[Q] • Investigation of choice[Q] – Digital subtraction carotid angiography

Inflammatory Causes of Proptosis

Features	Cavernous sinus thrombosis	Orbital apex syndrome[Q]	Orbital cellulitis
Cause	Due to uncontrolled infection in the dangerous area of face – orbital cellulitis and dacryocystitis **Cavernous sinus and internal carotid artery** Cranial nerve VI runs through the substance of the cavernous sinus while Cranial nerves III, IV and the maxillary and ophthalmic division of Cranial nerve V run through the outside layer of the cavernous sinus lateral wall	*Orbital apex syndrome results from the involvement of the superior orbital fissure and the optic canal* **Superior orbital fissure** transmits cranial nerves III[Q], IV[Q], VI[Q] and ophthalmic division of cranial nerve V (V-I)[Q] **Optic canal** transmits the optic nerve[Q]	*Results from extension of paranasal sinusitis into the orbit. Orbital cellulitis evolves with diffuse edema of orbital contents and may gradually evolve into an orbital abscess* **Orbital contents** All orbital contents may be involved
Onset and systemic features	*Abrupt/violent onset with marked systemic signs*[Q] High grade fever and headache present at onset	*Slower onset with less prominent systemic signs*	*Slower onset with less prominent systemic signs*
Anterior segments signs (periorbital, lid edema, chemosis)	Present simultaneously	Ophthalmoplegia precedes anterior segment signs and is out of proportion to them	Anterior segment signs precede ophthalmoplegia and are initially out of proportion to it
Vision	**Not affected in early stages** *Since optic nerve does not pass through the cavernous sinus, visual loss is not a prominent feature of CST although it may be seen in later stages from other causes*	**Lost in early stages** *Optic nerve passes through the apex. Impaired vision is early and more common in OAS compared to CST*	**May be lost early** *Diffuse involvement of the orbital contents may lead to optic neuritis and visual loss*
Laterality	**Often bilateral** Initially unilateral, but can become bilateral in more than 50% cases. Spread to the opposite eye through the intercavernous sinuses, usually within 24–48 hours is a common and characteristic feature of CST	**Unilateral**	**Unilateral**
Chemosis and proptosis	• Marked • Bilateral, axial, nonpulsatile proptosis	Mild to moderate	• Marked • Unilateral, axial, non-pulsatile proptosis
Ophthalmoplegia	**Sequential and complete** • **VIth cranial nerve** is involved **first**[Q] • **IIIrd** cranial nerve involvement may cause ptosis, internal ophthalmoplegia – loss of accommodation and mydriasis • **IVth** cranial nerve also involved	**Concurrent and complete** • Complete external • Ophthalmoplegia involving the CN **III**, **IV** and **VI** nerve is usually seen concurrently	**Concurrent and complete** • Complete external • Ophthalmoplegia involving the CN **III**, **IV** and **VI** nerve is usually seen concurrently
Trigeminal nerve involvement	Ophthalmic **(V-I)** and maxillary **(V-II)** division of cranial nerve V – leading to loss of corneal reflex	Ophthalmic division of cranial nerve V **(V-I)**	
Edema in mastoid region	Present (Diagnostic sign)	Absent	Absent
	• Fundus – initially normal – Retinal venous congestion[Q] and papilledema occur later • Magnetic resonance venography is the **investigation of choice**	Absent	Absent

EXTRA MILE

Orbital Cellulitis

- Bacteria are the most common cause of orbital infection – staphylococci[Q] and streptococci being most frequently isolated
- Ethmoid sinusitis[Q] is the most common cause of orbital cellulitis
- Stages – CHANDLER's classification

Severe lid swelling with proptosis

Discrete stages of orbital cellulitis

Stage	Features and pathophysiology
1	Inflammatory, **preseptal edema**[Q] of the eyelids. **Orbital signs (proptosis, ophthalmoplegia, visual decline) are absent**. Eyelid edema results from impaired venous and lymphatic drainage by the infected sinus.
2	**Proptosis and limitation of eye movement**. Diffuse postseptal orbital edema and infiltration by bacterial and inflammatory cells. Pain, fever and cerebral symptoms may arise
3	Defined by the presence of a **subperiosteal abscess** – a collection of fluid or purulent material between the orbital wall and periorbita, resulting in non-axial proptosis.
4	Severe nonaxial or axial proptosis, ophthalmoplegia, and visual decline. An intraorbital abscess (within the orbital periosteum) is present.
5	Bilateral proptosis, severe pain, and signs of meningeal inflammation, resulting from extension of the abscess posteriorly and the formation of cavernous sinus thrombosis

Idiopathic Orbital Inflammatory Disease

- Previously known as orbital pseudotumor
- Non-neoplastic, noninfective space occupying inflammatory lesion in the orbit
- Histopathology – Pleomorphic cellular infiltrate and fibrosis
- Most common between 40 and 60 years of age, males, unilateral presenting with pain, diplopia, proptosis and lid swelling.

Tolosa – Hunt Syndrome

- Nonspecific, idiopathic, granulomatous inflammation of cavernous sinus, superior orbital fissure or **orbital apex**.[Q]
- Presents with **acute ophthalmoplegia** with ipsilateral periorbital **pain**
- Responds well to **steroids** within a period of 24–48 hours

Neoplastic Causes of Proptosis

HIGH YIELD

ORBIT related MC(s)

MC cystic orbital lesions - Ductal cysts of lacrimal gland
MC cystic orbital tumour – Epidermoid and Dermoid
MC Orbital neoplasm (paediatric age) – Epidermoid and Dermoid
MC Orbital malignant tumor (paediatric age) – Rhabdomyosarcoma
Mc orbital and periorbital tumor in children – Capillary Hemangioma
MC benign Orbital tumour (adults) – Cavernous Hemangioma
MC malignant Orbital tumour (adults) – B cell NHL (lymphoma)
MC intrinsic lacrimal gland lesion/ lacrimal gland epithelial neoplasm – Pleomorphic Adenoma
MC orbital metastasis (paediatric age) – Neuroblastoma
MC peripheral neural tumour of the orbit – Plexiform neurofibroma
MC primary source of Orbital Metastases

- Breast – 42%
- Lung – 11% (most deaths)
- Neuroblastoma (paediatric age)

Thyroid-associated Ophthalmopathy (TAO)

Dysthyroid eye disease or Grave's ophthalmopathy (90% cases associated with Grave's disease) is the most common cause of unilateral and bilateral proptosis in adults[Q]. It may occur in patients who are hyperthyroid, euthyroid or hypothyroid.

Pathogenesis

It is an autoimmune (type II hypersensitivity reaction) in which antibodies produce the following changes

- Inflammation and enlargement of the extraocular muscles followed by fibrosis leading to compressive and restrictive myopathy
- Infiltration of inflammatory cells in the orbital fat

Clinical Features

- Soft tissue signs – periorbital and lid edema with conjunctival injection (Goldzeiher's sign – **Earliest sign**[Q] in TAO), chemosis and Superior limbic keratoconjunctivitis
  Earliest symptoms are excessive lacrimation, grittiness and photophobia
- Eyelid signs –
  - **Dalrymple sign** – lid retraction – **Most common** sign – 92% cases – occurs due to increased sympathomimetic tone causing contraction of Müller muscle and due to fibrosis
  - **Von graefe sign** – lid lag – lower lid moves down slowly on downgaze
  - **Kocher's sign** – freightened/staring appearance
  - **Stellwags sign** – reduced blinking frequency
  - Griffith sign – lid lag of lower lid during upagze
  - Enroth sign – edema of eyelid
  - Gifford's sign – difficulty in eversion of upper eyelid
  - Rosenbach sign – tremor of closed eyelids
  - Mobius sign – convergence weakness
  - Jellinker sign – abnormal pigmentation of upper eyelid

Right eyelid lag – Von graefe sign

Upper eyelid retraction in both eyes having sclera show – Dalrymple sign with mild Exophthalmos

- Proptosis – Exophthalmos – Axial, non-pulsatile – 2nd most common sign – 60% cases – leads to exposure keratitis
- Restrictive myopathy – ocular motility is restricted initially by edema and later by fibrosis leading to diplopia, squint and Loss of Bell's phenomenon
  Sequence of involvement is Inferior rectus[Q], Medial rectus, Superior rectus and Lateral rectus (IMSR)
  Earliest restriction is usually of Elevation[Q] **– due to contracture of Inferior rectus followed by Abduction restriction**
- Compressive Optic neuropathy – occurs in about 5% cases leading to visual loss.

Treatment

- Supportive care – lubricating eye drops (for dry eye due to eyelid retraction etc), cool compresses and head elevation (for periorbital edema)
- Guanethidine for eyelid retraction, but causes pain
- Botox to Müller's muscle for upper eyelid retraction
- Systemic steroids – effective to reduce the active inflammatory manifestations and for treatment of compressive optic neuropathy

- Orbital Radiation – improves ocular motility
- Surgery – Orbital decompression - for compressive optic neuropathy or for proptosis by expanding the orbital volume, either by removing fat or bone.

EYELIDS

ANATOMY

Grey line divides eyelid into 2 parts:

Anterior laminae
Consists of Skin (Thinnest skin in the body), subcutaneous tissue and muscles

Posterior laminae
Consists of Tarsal plate (No cartilage, only fibrous tissue) and the palpebral conjunctiva

Muscles in The Eyelid

	Orbicularis oculi	Levator Palpebri Superioris (LPS)	Müller's muscle (Tarsal)
Origin	Frontal process of maxilla and lacrimal bone	Sphenoid bone – apex of orbit Converted into a thin aponeurosis	Arises from the LPS
Insertion	Lateral palpebral raphe	Superficial layer into skin of lid – lid crease Deep layer into Tarsal plate	Tarsus
Nerve	Facial nerve[Q] – zygomatic branch	Oculomotor nerve[Q] – superior branch	Sympathetic nerve[Q]
Action	Eyelid closure[Q]	Elevation of the upper eyelid[Q]	Accessory upper eyelid elevator[Q]
Palsy	Lagophthalmos[Q]	Ptosis[Q]	Ptosis[Q]

Glands in The Eyelid

	Meibomian gland (Tarsal gland)	Zeis gland	Gland of Moll
Type	Modified sebaceous	Modified sebaceous	Modified sweat
Location	In tarsal plate	At the base of lash follicle	Between two lash follicles
Duct opening	Anterior to posterior margin of eyelids	In the lash follicle	In the ducts of zeis gland

INFLAMMATIONS OF THE GLAND OF EYELID

External hordeolum (Stye)	Internal hordeolum	Chalazion
Suppurative[Q] inflammation of **Zeis**[Q] gland	**Suppurative**[Q] inflammation of **Meibomian**[Q] gland	**Lipogranulomatous**[Q] inflammation of **Meibomian**[Q] gland
Staphylococcus aureus	*Staphylococcus aureus*	Non-infective
Swelling, pain and pus points **at the lid margin**	Swelling, pain and pus points away from lid margin	Painless **swelling away from lid margin**
Hot compression Topical and systemic antibiotics Epilation	Hot compression Topical and systemic antibiotics	Incision (vertical, on the posterior surface of eyelid) and Drainage Incision and curettage Intralesional steroids (Triamcinilone) injection
		Recurrent chalazion indicates chances of Sebcaeous cell carcinoma[Q]

External hordeolum

Acute, red, swelling at the lid margin

Chalazion

Swelling away from the lid margin without redness

ENTROPION

Inward turning of the eyelid margin leading to rubbing of the eyelashes on the cornea (pseudotrichiasis) which may lead to development of corneal opacity.

Classification and Treatment

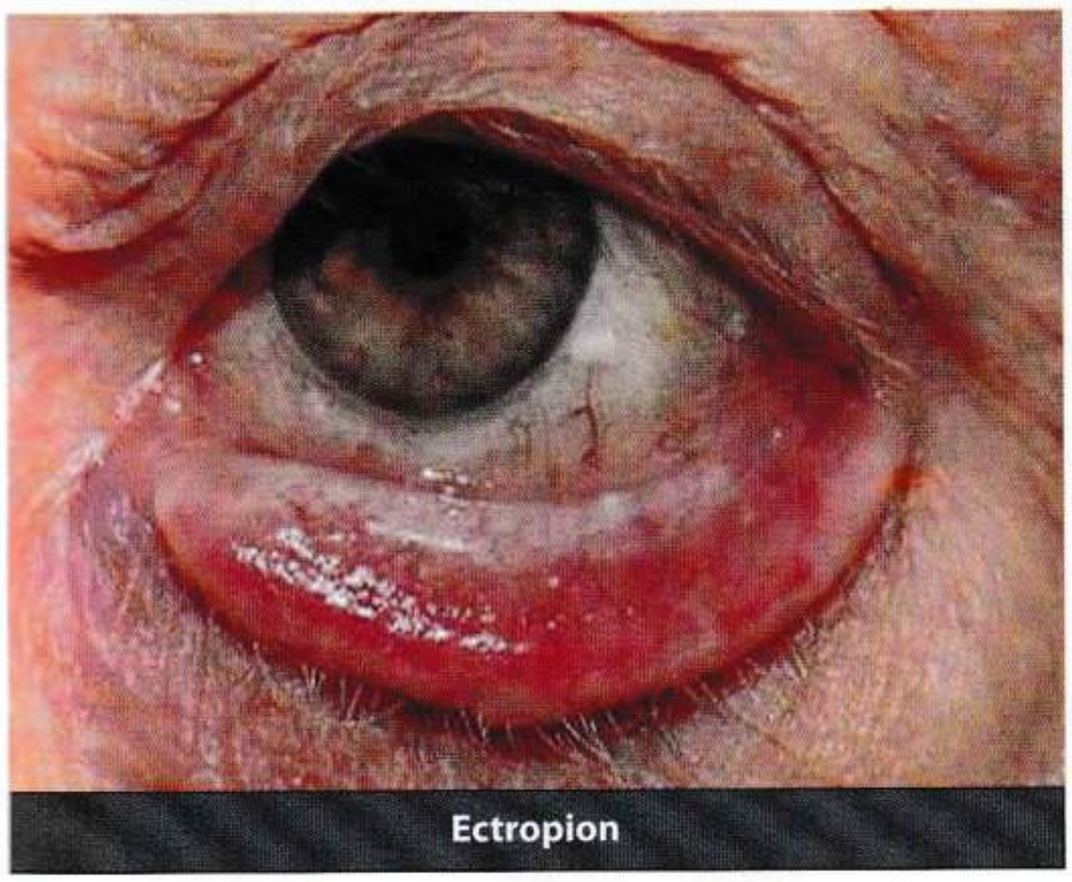
Congenital	Spastic	Senile (involutional)	Cicatricial	Mechanical
Rare condition may be associated with microphthalmos	Corneal irritation or light bandaging Seen in old people and affects lower lid	Seen in the elderly Affects the lower lid	Seen with trachoma, burns, membranous conjunctivitis Affects **upper lid**	Seen with phthisis bulbi, enophthalmos, enucleation
Treatment				
Plastic reconstruction of lid crease	• Treat cause of blepharospasm[Q] • ***Botulinum toxin***[Q] to relieve spasm • Surgeries (similar to senile entropion)	• Modified *Wheelers*[Q] *operation* • *Weiss operation* • *Plication of the inferior lid retractors (Lester Jones operation)* • *Bick procedure*	• Wedge resection • Modified ***Burrows*** operation – Tarsal fracture • **Jaesche Arlt's** operation	

ECTROPION

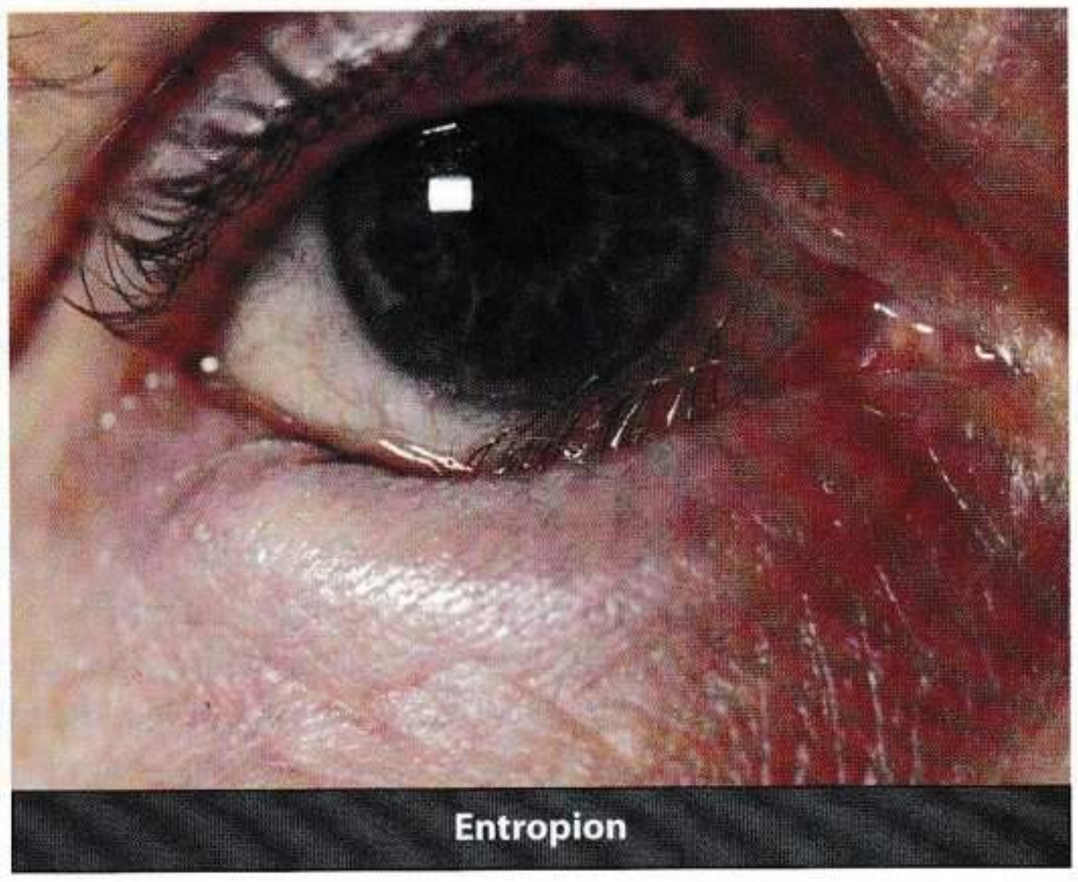
Outward turning of the eyelid margin commonly leading to epiphora.

Classification and Treatment

Senile	Cicatricial	Paralytic	Spastic	Mechanical
• **Most common type**[Q] • Affects lower lid only	• Chemical and thermal burns, skin ulcers, lacerating injuries • Can involve both lids	• VII nerve palsy • Affects lower lids • Bell's palsy, head injury • Middle ear infections	Rare condition	• Tumors • Proptosis
Treatment				
• Medial conjunctivoplasty • Horizontal lid shortening • Bryon Smith's modified Kuhnt Szymanowski operation	• V-Y operation • Z plasty • Scar tissue excision with full thickness skin graft	• Lateral tarsorrhaphy • Palpebral sling operation • Botulinum toxin to induce temporary ptosis of upper eyelid		Treat the cause



Ectropion



Entropion

PTOSIS

It is **drooping of the upper eyelid** in relation to the globe, covering more than 2 mm of the superior cornea. It is due to pathologies affecting either the LPS or Müller's muscle as they are responsible for the retraction of the upper eyelid.

Classification

Congenital Ptosis

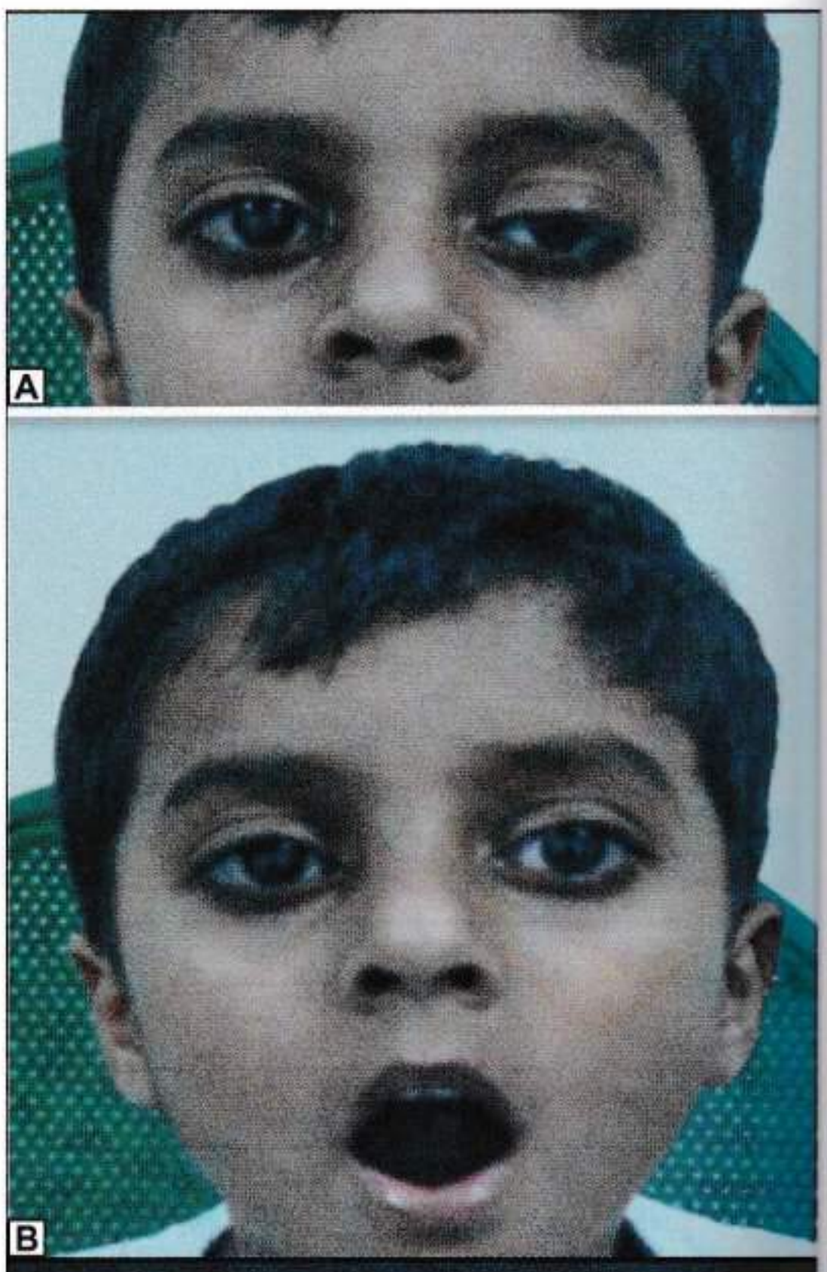
- Simple
  - Due to **defective** development of the LPS muscle (Myogenic)[Q]
  - Presents with **Absent upper lid crease**[Q]
  - **Poor levator function**[Q]
  - In downgaze the ptotic eyelid is higher than the normal because of poor relaxation of the levator (Lid Lag)[Q]
  - Refractory errors are common and responsible for **anisometropic amblyopia**[Q]
  - Usually unilateral (69%)
  - May be associated with strabismus in 30% cases
  - In severe ptosis, chin elevated head posture and/or forced elevation of eyebrows by contraction of frontalis muscle which leads to wrinkling of forehead.

Congenital Ptosis - left upper eyelid crease is absent

Treatment	
a. Mild ptosis and good levator function	Fasanella servat operation
b. Moderate ptosis and fair levator function	Levator resection surgery (Blaskowics or everbusch)
c. Severe ptosis and poor levator function	Frontalis sling surgery
Surgery is done around 5 years of age.	

- Complications
  - **Blepharophimosis syndrome**[Q]**:** congenital ptosis + blepharophimosis (Horizontal shortening of the palpebral aperture + epicanthus inversus + telecanthus + lateral ectropion of the lower lids
  - **Hypotropic** – due to superior rectus weakness
  - 3rd nerve misdirection syndrome
  - **Synkinetic – Marcus-Gunn jaw winking syndrome**[Q] – retraction of the ptotic eyelid in conjunction with stimulation of ipsilateral pterygoid muscle by mastication

    It is postulated to be due to trigemino-oculomotor synkinesis
    - Mild cases – ULE >5 mm – unilateral levator resection
    - Moderate cases – unilateral levator resection with disinsertion and sling surgery



Patient with Marcus Gunn Jaw-Winking phenomenon. (A) 5 year old child with unilateral upper eyelid ptosis as part of Marcus Gunn phenomenon. (B) Elevation of concomitant upper eyelid with mouth opening

Acquired Ptosis

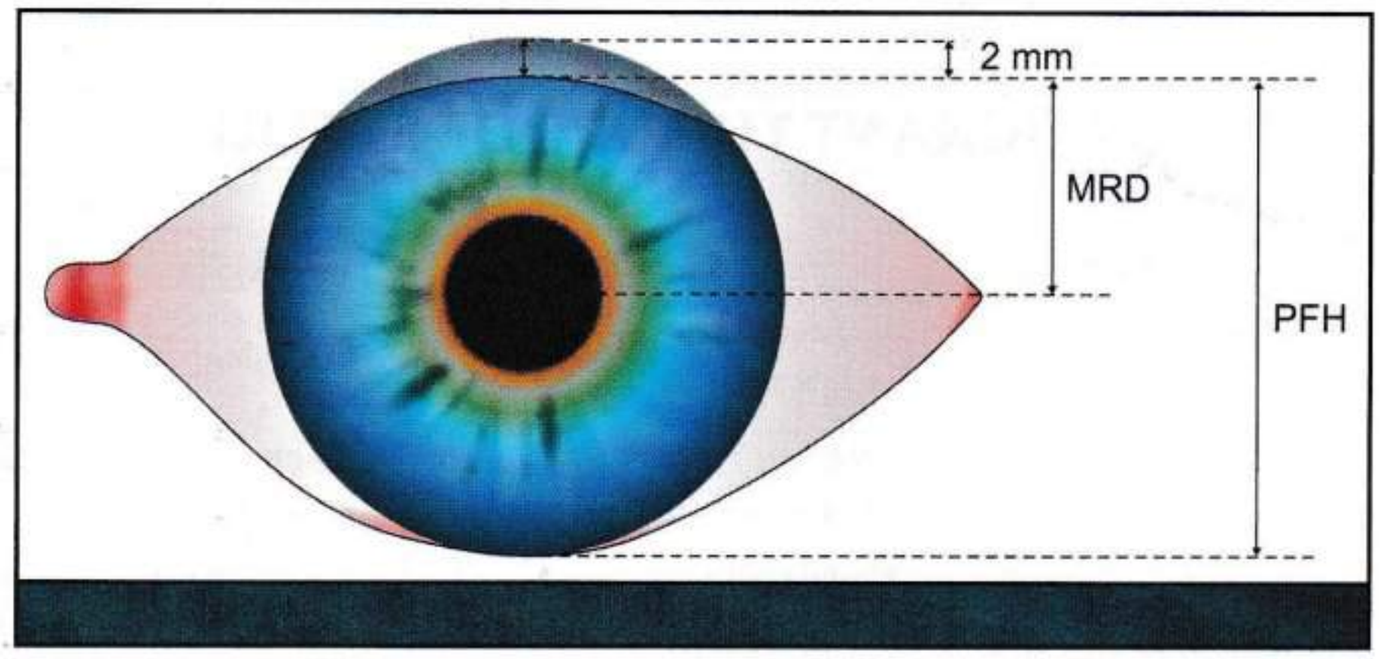
Neurogenic ptosis	Myogenic ptosis	Aponeurotic ptosis	Mechanical ptosis
Cause			
• 3rd cranial nerve palsy • Horner's syndrome • 3rd nerve misdirection • Multiple sclerosis	• Myasthenia gravis (discussed in Ch 3) • Myotonic dystrophy • Ocular myopathy • Lambert-Eaton myasthenia syndrome • Thyrotoxicosis	• Disinsertion of the levator aponeurosis • Involutional **Most common type**[Q]	• Increased weight on upper eyelid due to tumors, edema, chalazia • Cicatricial – scarring as in trachoma
Treatment			
• LPS resection • Fasanella servat operation (Horner's syndrome)	LPS resection or sling surgery	Aponeurotic strengthening procedures	Treat the cause

Clinical Evaluation

PFH (palpebral fissure height)	
Distance between upper lid and lower lid margin	Normal: ~9 mm

	Drooping	Visible cornea
Mild ptosis	≤ 2 mm	7 mm
Moderate ptosis	3 – 4 mm	6 mm
Severe ptosis	> 4 mm	< 5 mm

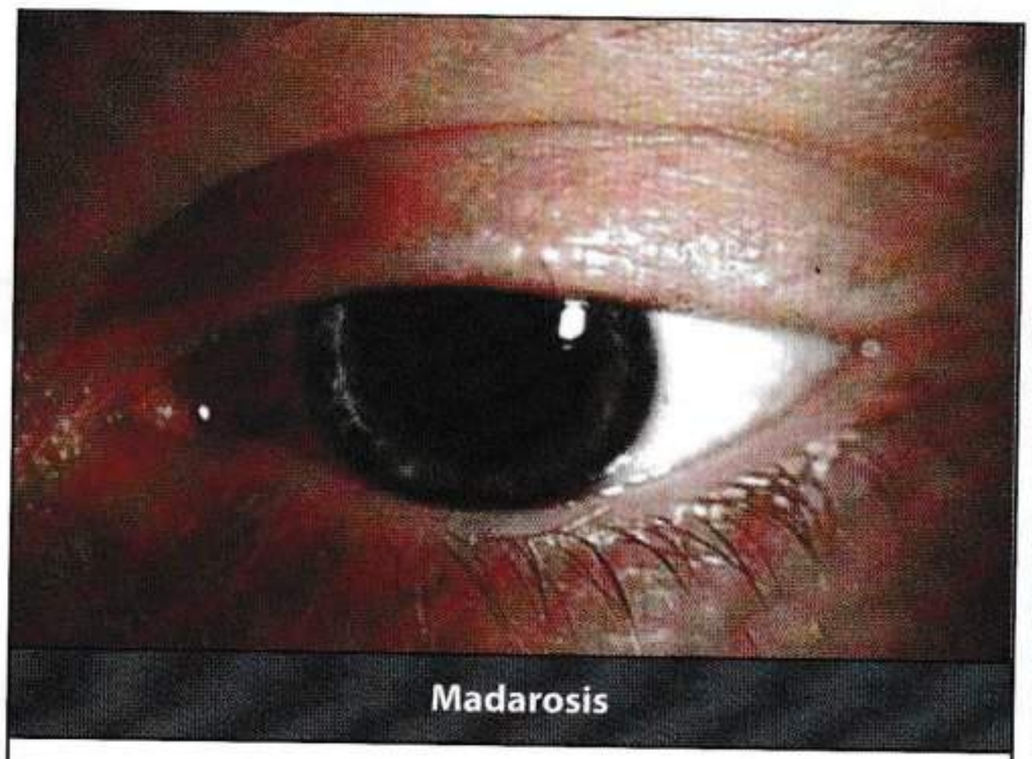
MRD (Marginal reflex distance)	
Distance between upper lid margin and the corneal light reflection of a pen torch	Normal: 4 – 4.5 mm
Levator function	
Assessed as amount of upper lid excursion (ULE), i.e. movement of upper lid margin (measured in mm) from downgaze to upgaze	Normal: 15 mm Good: ≥ 8 mm Fair: 5 – 7 mm Poor: ≤ 4 mm
Upper lid crease	
Absent in congenital ptosis	High crease suggests an aponeurotic ptosis
Bell's phenomenon	
Patient tries to shut his eyes while examiner manually holds eyelid open. Upward and outward rotation of eyeball occurs.	Weak Bell's phenomenon is an absolute contraindication of surgery as it can lead to post operative exposure keratopathy.



DISORDERS OF EYELASHES

Trichiasis[Q]	Posterior misdirection/Inward turning of the cilia, which rub on cornea Treated by Epilation, Cryotherapy
Distichiasis[Q]	Second row of eyelashes Usually inherited AD and associated with lymphedema of the legs
Trichomegaly	Excessive growth of eyelashes
Madarosis	Loss of eyelashes (Lateral 1/3rd)
Poliosis	Premature localized whitening of eyelashes and eyebrows
Tylosis	Thickening of the eyelid margin
Lagophthalmos	Inability to voluntarily close the eyelids, resulting in exposure keratitis

Ankylobleharon	Adhesion between margin of upper and lower eyelid margin
Symblepharon	Adhesion between palpebral and bulbar conjunctiva
Blepharitis Acarcia	Due to a parasite *Demodex folliculorum*
Phthiriasis palpebrarum	Caused by Phthirus pubis (crab louse). Treated with topical yellow mercuric oxide 1% or petroleum jelly



Madarosis

Loss of Upper eyelashes seen

Trichiasis

Inturning of upper eyelashes seen

MALIGNANT TUMORS OF EYELID

Type	Common site	Clinical features	Spread	Treatment
Basal cell carcinoma	Lower lid medially	Nodule with central ulceration, telangiectasia	Local	Resection, radiation
Small cell carcinoma	Lower lid	Ulcer with thickened margin, keratosis	Local, lymph node	Resection, radiation, cryotherapy
Sebaceous cell carcinoma	Upper lid	Nodule assembling Chalazion, more common in females	Local, intraepithelial, lymph nodes	Resection, Cryotherapy, Exenteration
Malignant melanoma	From previous nevi	Nodule 6 mm size, pigmented lesions	Local, vascular, lymph nodes	Resection, Exenteration

IMAGE-BASED QUESTIONS

There are multiple probable questions that can be asked on a single image.

Question numbers 1 to 3 are based on Image 1.

Image 1

1. **Identify the condition in the above image.**
   a. Complete cryptophthalmos
   b. Incomplete cryptophthalmos
   c. Total ankyloblepharon
   d. Euryblepharon
2. **All of the following statements are true about the above condition except**
   a. It can be unilateral or bilateral
   b. It is associated with systemic abnormalities
   c. It is associated with a good visual prognosis
   d. The underlying eye may show some reaction to light
3. **The newborn in the above image may have all of the following except**
   a. Microphthalmos
   b. Syndactyly
   c. Genitourinary abnormalities
   d. Macrostomia

Question numbers 4 to 7 are based on Image 2.

Image 2

4. **Identify the ocular pathology**
   a. Entropion
   b. Trichiasis
   c. Trachoma
   d. Ectropion
5. **The above image is taken from a 70 year-old woman who complained of left epiphora and ocular irritation. She had left lower lid basal cell carcinoma excision six months earlier. What is the diagnosis?**
   a. Cicatricial entropion
   b. Senile ectropion
   c. Involutional entropion
   d. Floppy eyelid syndrome
6. **The above condition can result from all of the following except**
   a. Burns
   b. Chalazion
   c. Trauma
   d. Eyelid skin excision
7. **The 65 year old lady in the above image presented with epiphora. There is lateral canthal tendon laxity. What is the most appropriate surgical option?**
   a. Wedge resection
   b. Weiss procedure
   c. Tarsal strip
   d. Modified wheeler's operation

Question numbers 8 to 11 are based on Image 3.

Image 3

8. **Identify the lid condition.**
   a. Horedolum externum
   b. Hordeolum internum
   c. Chalazion
   d. Stye
9. **Which instrument is seen in the image**
   a. Chalazion scoop
   b. Chalazion clamp
   c. Desmarre's lid retractor
   d. Cryoprobe
10. **All of the following are true about the above eyelid condition except**
    a. It is a painless nodule
    b. Involves the meibomian gland
    c. Located within the tarsal plate
    d. More common in children

11. **Which of the following is true regarding the treatment of the condition in the image, except?**
    a. Complete spontaneous resolution occurs in almost 90% cases
    b. The cyst in incised vertically through the skin and curetted
    c. Intralesional injection of steroid is preferred if close to the lacrimal punctum
    d. Tetracycline can stop the recurrence

Question number 12 is based on Image 4.

Image 4

12. **Identify the ocular pathology.**
    a. Trichiasis
    b. Distichiasis
    c. Poliosis
    d. Tylosis

Question number 13 is based on Image 5.

Image 5

13. **The patient in the image is most likely a case of**
    a. Cavernous sinus thrombosis
    b. Orbital cellulitis
    c. Orbital apex syndrome
    d. Orbital varices

Question number 14 is based on Image 6.

Image 6

14. **8 years old female brought by her mother with the features as shown in this picture. Her father is also having similar feature. What is the most likely diagnosis?**
    a. Usher syndrome
    b. Blepharophimosis syndrome
    c. Horner syndrome
    d. Marfan's syndrome

Question number 15 is based on Image 7.

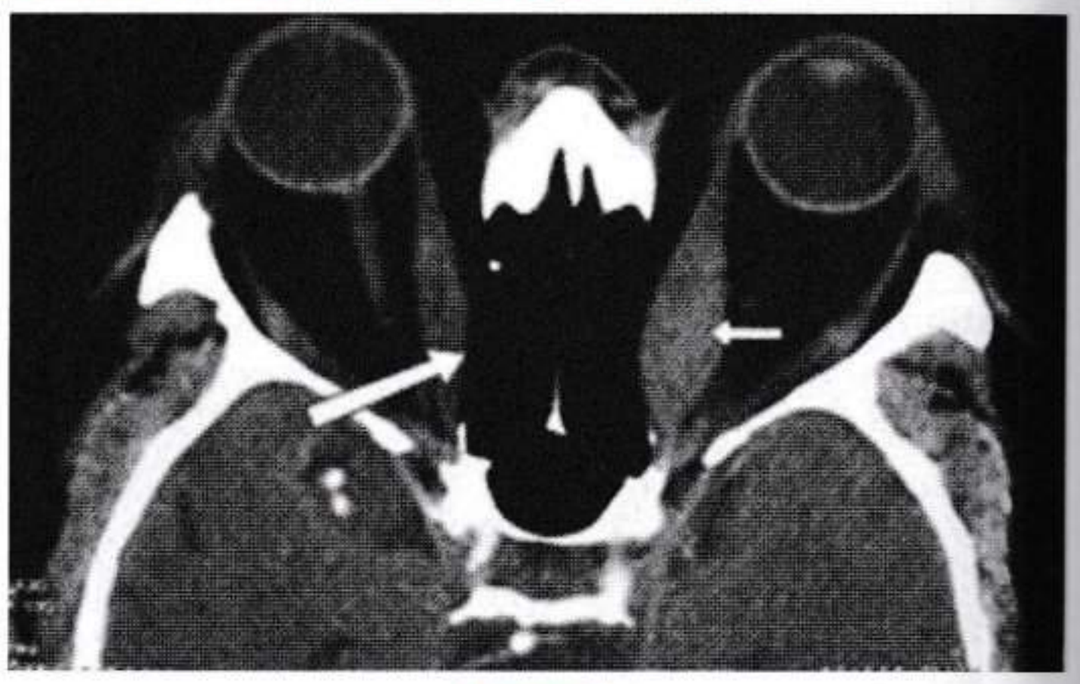


Image 7

15. **What is the cause for enlargement of muscle shown in this CT-scan?**
    a. Pseudotumor
    b. Myositis
    c. Rhabdomyosarcoma
    d. Grave's ophthalmopathy

Question number 16 is based on Image 8.

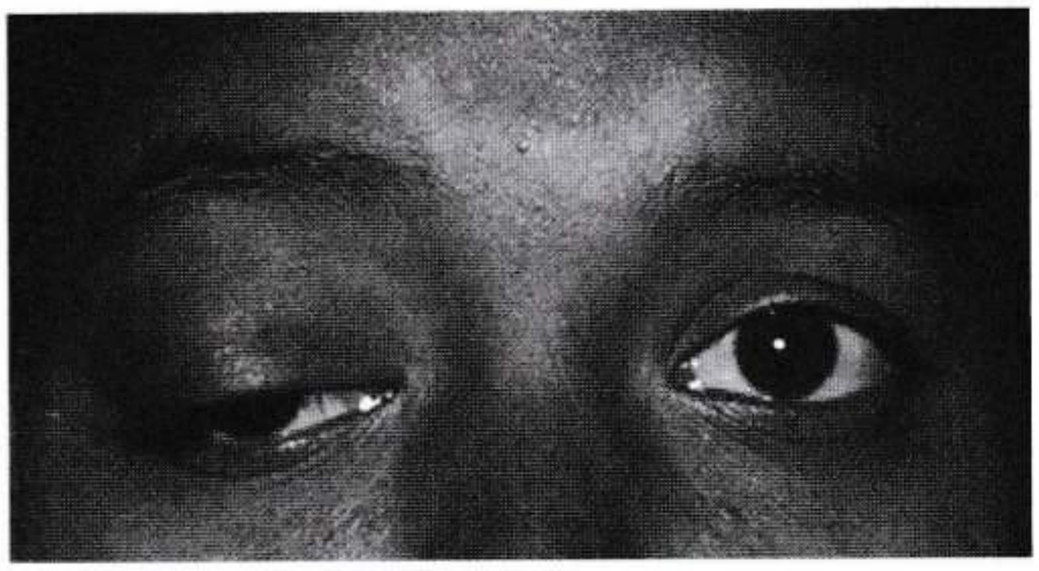


Image 8

16. **Identify the finding seen in the image 8.** *(AIIMS May 2017)*
    a. Ptosis of right eye
    b. Entropion of right eye
    c. Enophthalmos of right eye
    d. Ectropion of left eye

Question number 17 is based on Image 9.

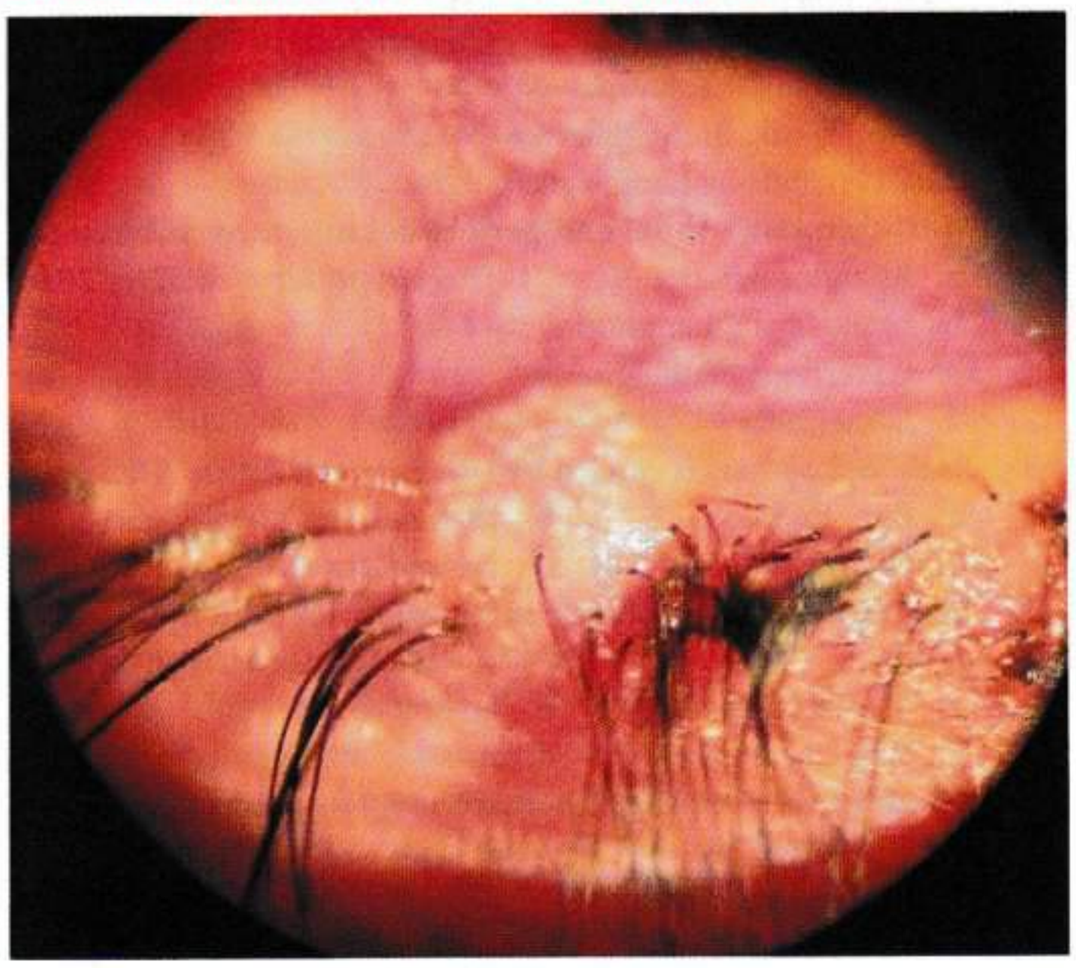


Image 9

17. **Identify the lesion**
    a. Molluscum contagiosum
    b. Hordeolum externum
    c. Basal cell carcinoma
    d. Keratocanthoma

Question number 18 is based on Image 10.

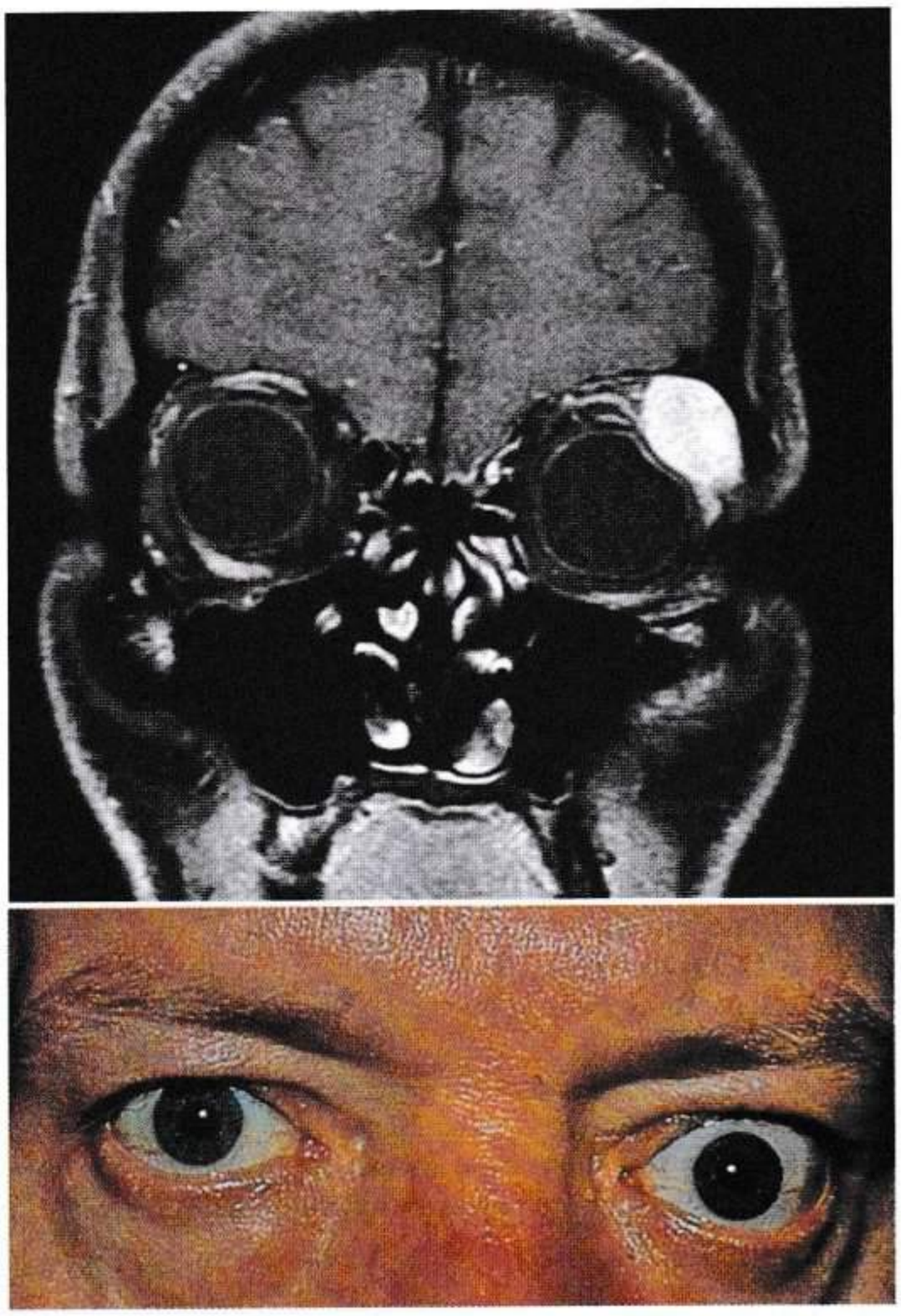


Image 10

18. **Based on the clinical picture and CT scan result given, what is the most probable diagnosis?**
    a. Pleomorphic lacrimal gland adenoma
    b. Optic nerve glioma
    c. Lacrimal mucocele
    d. Cavernous Hemangioma

MULTIPLE CHOICE QUESTIONS

19. Ectropion of left eye Periosteum of orbit is strongly attached to:
a. Medial wall of orbit b. Lateral wall of orbit
c. Floor of orbit d. Roof of orbit
e. Suture lines

20. Lateral wall of orbit is/are formed by:
a. Lesser wing of sphenoid
b. Frontal process of zygomatic bone
c. Greater wing of sphenoid
d. Lacrimal bone
e. Maxilla

21. Structures passing through superior orbital fissure: *(PGI Nov 2011)*
a. 2nd CN b. 3rd CN
c. 4th CN d. 6th CN
e. Lacrimal nerve

22. What is ligament of lockwood related to *(Recent pattern Nov/Dec 2016; PGI May 2018)*
a. Gall bladder b. Scrotum
c. Orbit d. Lens

23. A child presents with unilateral proptosis which is compressible and increases on bending forwards. It is non-pulsalite and has no thrill or bruit. MRI shows retro-orbital mass with echogenic shadows. The most probable diagnosis is: *(AIIMS Nov 2006, May 2010)*
a. Orbital varix
b. Orbital Encephalocoele
c. Orbital A–V malformation
d. Neurofibromatosis

24. Axial proptosis is associated with
a. Optic glioma b. Dermoid cyst
c. Lacrimal gland tumors d. Maxillary tumors

25. Most common cause of bilateral proptosis in children is *(AIIMS Nov 2013)*
a. Rhabdomyosarcoma b. Retinoblastoma
c. PNET d. Neuroblastoma

26. Most common intraocular metastasis in females are from which of the following primary tumor? *(AIIMS May 2013)*
a. Breast b. Ovary
c. Cervix d. Endometrium

27. Bilateral proptosis in children is the most common presentation of: *(AIIMS Nov 2012)*
a. Neurofibromatosis
b. Chloroma
c. Cavernous hemangioma
d. Malignant fibrous histiocytoma

28. The most common cause of bilateral proptosis in children is: *(All India 2011)*
a. Cavernous hemangioma
b. Fibrous histiocytoma
c. Chloroma (Leukemia)
d. Rhabdomyosarcoma

29. A patient developed proptosis and diplopia of 2 months duration following injury. On examination there is chemosis, conjunctival redness, and external ocular nerve palsy. Investigation of choice is: *(AIIMS Nov 2011)*
a. MRI b. CECT
c. MR angiography
d. Intra-arterial digital subtraction angiography

30. Following a RTA on fourth day, a person developed proptosis and pain over right eye. On examination there is bruise on the eye and forehead. What may be the diagnosis: *(AIIMS Nov 2011)*
a. Fracture sphenoid
b. Cavernous sinus thrombosis
c. Internal carotid artery aneurysm
d. Carotid cavernous fistula

31. A patient with history of running nose and pain over medial aspect of the eye presents with sudden onset of high grade fever, prostration, chemosis, proptosis and diplopia on lateral gaze with congestion of the optic disc. Which of the following is the most likely diagnosis *(All India 2011)*
a. Acute ethmoidal sinusitis
b. Orbital cellulitis
c. Cavernous sinus thrombosis
d. Orbital apex syndrome

32. Most common primary intraorbital malignant neoplasm in children is *(Recent pattern 2013-14)*
a. Rhabdomyosarcoma b. Retinoblastoma
c. Pleomorphic adenoma d. Cavernous haemangioma

33. True about orbital rhabdomyosarcoma: *(PGI May 2014)*
a. Arise from pleuripotent mesenchymal cell
b. Origin from skeletal muscle cell
c. Usually Bilateral
d. Female predisposition
e. More common in children

34. Most common malignant orbital tumor in adults
a. Hodgkin lymphoma *(Recent pattern Nov/Dec 2016)*
b. Malignant melanoma
c. Non-Hodgkin lymphoma
d. Cavernous hemangioma

35. Most common orbital and periorbital tumor in children is
a. Rhabdomyosarcoma *(Recent pattern Nov/Dec 2016)*
b. Capillary hemangioma
c. Cavernous hemangioma
d. Lymphoma

36. Pseudoproptosis is caused by *(Recent pattern Nov/Dec 2016)*
a. Buphthalmos b. Meningioma of optic nerve
c. Orbital cellulitis d. Dermoid cyst

37. The most common muscle involved in Thyroid ophthalmopathy is *(Recent pattern July 2015)*
a. Medial rectus b. Lateral rectus
c. Superior rectus d. Inferior rectus

38. All of the following are characteristics of preseptal cellulitis except *(Recent pattern 2014)*
a. Proptosis and chemosis
b. Periorbital edema
c. Unimpaired pupillary reaction
d. Normal visual acuity

39. The most common retrobulbar orbital mass in adults is: *(Recent pattern Nov/Dec 2016)*
a. Neurofibroma b. Meningioma
c. Cavernous hemangioma d. Schwannoma

40. Which sinus infection most commonly leads to periorbital cellulitis?
a. Ethmoidal b. Maxillary
c. Sphenoidal d. Frontal

Most Recent Questions of 2019-2017 are given at the end

41. **Most common cause of orbital cellulitis is?**
a. Bacillus anthracis b. H. influenza
c. Staphylococcus aureus b. Mucormycosis

42. **Tolosa Hunt syndrome involves** *(Recent pattern Dec 2016)*
a. Orbital floor b. Orbital apex
c. Orbital roof d. Orbital space

43. **Thyroid eye disease is due to** *(Recent pattern Nov 2015)*
a. Thyrotoxicosis b. Hypothyroidism
c. Euthyroidism d. Hashimoto's disease

44. **A tumor has the following characteristics- retrobulbar location within the muscle cone, well defined capsule, presents with slowly progressive proptosis, easily resectable, occurs most commonly in the 2nd to 4th decade. Most likely diagnosis is –** *(AIIMS May 2008)*
a. Capillary hemangioma b. Cavernous hemangioma
c. Lymhangioma d. Hemangiopericytoma

45. **Pulsatile proptosis is a feature of-** *(Recent pattern Dec 2013)*
a. Orbital varix
b. Retinoblastoma
c. Carotid cavernous fistula
d. Cavernuos sinus thrombosis

46. **Axial proptosis is produced by tumors lying in –** *(Recent pattern Dec 2015)*
a. Retrobulbar space b. Subperiosteal space
c. Tenon space d. Peripheral space

47. **Most common ocular movement affected in thyroid ophthalmopathy –** *(Recent pattern Dec 2013)*
a. Adduction b. Abduction
c. Elevation d. Depression

48. **All the following signs could result from infection within the right cavernous sinus except –** *(AIIMS May 2003)*
a. Constricted pupil in response to light
b. Engorgement of the retinal veins upon ophthalmoscopic examination
c. Ptosis of the right eyelid
d. Right Ophthalmoplegia

49. **Orbital apex syndrome constitutes all except -**
a. Ptosis *(Recent pattern Dec 2014)*
b. CSF rhinorrhea
c. Ophthalmoplegia
d. Pain over distribution of optic nerve

50. **Tarsal muscles are supplied by?**
a. Ophthalmic nerve b. Nasociliary nerve
c. Sympathetic nerves d. Oculomotor nerve

51. **A patient presents with an upper eyelid swelling. Diagnosis of Chalazion is made. Histopathology would reveal:** *(AIIMS May 2013)*
a. Suppurative granulomatous inflammation
b. Lipogranulomatous inflammation
c. Xanthogranulomatous inflammation
d. Foreign body granulomatous inflammation

52. **A biopsy was performed for a patient with recurrent chalazion involving the upper lid. The most likely diagnosis on histopathology is:**
a. Sebaceous cell carcinoma
b. Basal cell carcinoma
c. Squamous cell carcinoma
d. Malignant Melanoma

53. **All of the following is true about External hordeolum except** *(Recent pattern Dec 2016)*
a. Inflammation of sebaceous glands of Zeis
b. Caused by staphylococcus aureus
c. Inflammation of meibomian gland
d. Also called as Stye

54. **All are true regarding congenital ptosis except:**
a. Levator palpebrae superioris dystrophy may present
b. Associated with diplopia
c. Lid crease is decreased
d. Amblyopia can occur

55. **What is the treatment of choice for congenital ptosis?**
a. Levator resection *(Recent pattern 2013)*
b. Fasanella Servat procedure
c. Modified wheeler procedure
d. Bick procedure

56. **All the following are surgeries for ptosis correction except** *(DNB 2012)*
a. Brow suspension b. Levator resection
c. Müller resection d. Müller recession

57. **Adhesion of bulbar conjunctiva to palpebral conjunctiva is known as** *(DNB 2012)*
a. Symblepharon b. Anophthalmos
c. Ankyloblepharon d. Pinguecula

58. **Distichiasis is misdirected eye lashes** *(Recent pattern July 2016)*
a. From normal sites b. From abnormal sites
c. Secondary to entropion d. None of the above

59. **Eye lid tumors are:**
a. Squamous cell carcinoma
b. Sebaceous gland carcinoma
c. Malignant melanoma
d. Basal cell carcinoma
e. Malignant germ cell tumor

60. **Enophthalmos caused by fracture of**
a. Floor of orbit *(Recent pattern Dec 2015)*
b. Medial wall of orbit
c. Lateral wall of orbit
d. Roof of orbit

61. **Paralysis of IIIrd, IV and VIth cranial nerve with involvement of ophthalmic division of the Vth cranial nerve localises the lesion to:** *(AIPG 2010)*
a. Cavernous sinus b. Apex of the orbit
c. Brainstem d. Base of the skull

62. **An 8-year-old boy presents with proptosis in the left eye for 3 months. CT scan reveals intraorbital extraconal mass lesion. Biopsy shows embryonal rhabdomyosarcoma. Metastatic workup is normal. The standard line of management is:** *(AIIMS 2010)*
a. Chemotherapy
b. Wide local excision
c. Chemotherapy and radiotherapy
d. Enucleation

63. **All of the following types of lymphoma may be seen in the orbit except:** *(AIIMS 2003)*
a. Non-Hodgkin's lymphoma, mixed lymphocytic and histiocytic
b. Non-Hodgkin's lymphoma, poorly differentiated
c. Burkitt's lymphoma
d. Hodgkin's lymphoma

Most Recent Questions of 2019-2017 are given at the end

64. Most common type of optic nerve glioma is: *(Recent pattern Dec 2013)*

a. Oligodendrocytic b. Fibrous
c. Protoplasmic d. Pilocytic

65. Eyelid drooping is/are seen in: *(PGI Nov 2010)*

a. Damage to edinger-westphal nucleus
b. Damage to motor part of facial nerve
c. Damage to sympathetic nerve supply
d. Damage to motor root of oculomotor nerve
e. Damage to lacrimal nerve

Most Recent Questions of 2019-2017

66. MC tumor of lacrimal gland *(AIIMS Nov 2017)*

a. Pleomorphic adenoma
b. Mucoepidermoid cancer
c. Adenoid cystic carcinoma
d. Non Hodgkin lymphoma

67. Most common cause of fungal orbital cellulitis in diabetes *(Recent pattern 2017)*

a. Aspergillus b. Fusarium
c. Mucormycosis d. Candida

68. Hordeolum internum is inflammation of which of the following *(Recent pattern 2017)*

a. Zeis gland b. Meibomian gland
c. Gland of moll d. Krause gland

69. True about inferior ophthalmic vein *(PGI May 2017)*

a. Smaller than superior ophthalmic vein
b. Connected to the pterygoid venous plexus
c. Formed at lateral wall and floor of orbit
d. Pass through superior orbital fissure
e. Empties into superior ophthalmic vein

70. All are true about congenital ptosis except *(PGI May 2017)*

a. Stimulus deprivation amblyopia may occur if treatment is delayed
b. Lid lag on downgaze
c. Prominence of lid crease
d. Loss of lid crease
e. Associated with weakness of the levator palpebrae superioris

71. Which of the following statement(s) is/are true about glands of eyelids *(PGI May 2017)*

a. Moll glands are modified sebaceous
b. Tarsal glands are meibomian glands
c. Gland of zeis are sweat gland
d. Meibomian glands are modified sebaceous glands
e. External hordeolum is an acute suppurative inflammation of gland of Zeis

72. Which of the following is true regarding Tarsal plate?

a. Not under sympathetic control *(PGI May 2018)*
b. Has meibomian glands
c. Has cartilage
d. Acts as skeleton of eye

73. A 5-year-old boy presents with Severe ptosis associated with poor levator function. Which of the following will be the treatment? *(Recent question Jan 2019)*

a. Frontalis Suspension surgery
b. Levator resection
c. Mullerectomy
d. Fasnella servat operation

ANSWERS TO IMAGE-BASED QUESTIONS

1. Ans. (a) Complete cryptophthalmos

Option a/b – Cryptophthalmos is the congenital absence of eyelid with skin passing continuously from the head to the cheeks over a malformed eye

- Complete – lids are replaced by a layer of skin which is fused
- Incomplete – microphthalmos, rudimentary lids and a small conjunctival sac

Option c – Total Ankyloblepharon (Pseudo-cryptophthalmos) is a condition in which a fully formed eye is covered by eyelids and brows and eyelashes are present.

Option d – Euryblepharon is a symmetrical enlargement of the palpebral aperture associated with large eyelids.

2. Ans. (c) It is associated with a good visual prognosis

Option a – it can be both unilateral and bilateral, though frequently it is Bilateral

Option b – FACT (read A3 please)

Option c – it is associated with a poor visual prognosis except the abortive form, as the overlying skin is fused with the underlying metaplastic cornea

Option d – even in the complete form the underlying eye moves and may even show some reaction to light in the form of contractions of periocular skin.

3. Ans. (d) Macrostomia

Option a – cryptophthalmos without systemic associations is always accompanied by a microphthalmic eye.

Option b/c - Cryptophthalmos is often associated with systemic abnormalities in an AD inherited condition known as FRASER syndrome, which is characterized by

- Syndactyly
- Urogenital abnormalities
- Craniofacial abnormalities

4. Ans. (d) Ectropion

Out turning of the eyelid can be seen – thus Ectropion

5. Ans. (a) Cicatricial entropion

Ref: Kanski 7/e, p. 46-48

Option a - The patient has cicatricial ectropion of the left lower lid. Defects in the lower lid that are closed horizontally (within

Most Recent Questions of 2019-2017 are given at the end

the lines of Langer) can occasionally *shorten the anterior lamellae* and produce postoperative SPASTIC/ CICATRICIAL ectropion.

Cicatricial ectropion is caused by scarring or contracture of the skin and the underlying tissues which pulls the eyelid away from the globe.

Option d – Floppy eyelid syndrome affects obese men, upper eyelid ectropion, often accompanied by obstructive sleep apnea.

6. Ans. (b) Chalazion

Chalazion doesnot cause scarring and thus no cicatricial ectropion.

7. Ans. (c) Tarsal strip

Ref: Yanoff 4/e, p. 1287

Lateral tarsal strip procedure is used to correct both lateral canthal tendon laxity and generalized horizontal lid laxity.

8. Ans. (c) Chalazion

9. Ans. (b) Chalazion clamp

Ref: Kanski 7/e, p. 5

10. Ans. (d) More common in children

Option a – patient presents with a painless, hard swelling on either lid, increasing gradually in size, without inflammatory symptoms.

Option b – It is a chronic, sterile granuloma of the meibomian gland caused due to retained secretions.

Option c – Fact

Option d – More common in adults than in children.

11. Ans. (c) Intralesional injection of steroid is preferred if close to the lacrimal punctum

Ref: Kanski 7/e, p. 4

Option a – They become smaller over months, but complete resolution occurs in only 1/3rd.

Option b – The cyst is incised vertically (as seen in the image), after eversion of the eyelid with a special clamp, through the conjunctiva, and its contents are curetted through the tarsal plate.

Option c – to avoid the risk of surgical damage.

Option d – it is a noninfective, sterile condition.

12. Ans. (b) Distichiasis

Ref: Kanski 7/e, p. 27

Option a will the wrong answer by a lot of us – But remember Trichiasis is characterized by posterior misdirection of lashes arising from normal sites of origin.

Whereas in the image, even though in-turning of eyelashes may be seen, the eyelashes are present at abnormal sites – double row of eyelashes - distichiasis.

13. Ans. (a) Cavernous sinus thrombosis

Ref: Parson's 22/e, p. 489-490

Option b – Orbital cellulitis is rarely bilateral

Option c – OAS is unilateral

Option d – No chemosis and eyelid swelling

14. Ans. (b) Blepharothimosis syndrome

Ref: Khurana 6/e, p. 379

Telecanthus, ptosis, epicanthal fold and ectropion all are features of this syndrome.

15. Ans. (d) Grave's ophthalmopathy

Ref: Parson's, 22/e, p. 487

Thyroid eye disease produce typical Fusiform enlargement of extraocular muscles and spares the tendon.

16. Ans. (a) Ptosis of right eye

Ref. Kanski 8/e, p. 40-42. Khurana 6/e, p. 379

Ptosis – drooping of the upper eyelid in relation to the globe covering more than 2 mm of the cornea superiorly.

17. Ans. (a) Molluscum contagiosum

Ref: Parson's 22/e, p. 452; Kanski 7/e, p. 33

Small, white **umblicated** swelling involving the eyelid surface or the lid margin

Treatnment is Incision and expression with povidone iodine application

18. Ans. (a) Pleomorphic lacrimal gland adenoma

Ref: Parson's 22/e, p. 474

Option b and d – Both will cause axial proptosis and thus anterior globe displacement

Option c – Swelling will be seen in CT near the lacrimal sac, that is at the medial end of orbit

Option a – Lacrimal gland tumour presents with downward and inward globe displacement of the left eye and CT shows a oval mass with smooth outline without destruction of the bony

ANSWERS TO MULTIPLE CHOICE QUESTIONS

19. Ans. (e) Suture lines

Ref: Khurana Anatomy and Physiolgy 6/e, p. 492-493

Periosteum lining the surface of the orbital bones in called the Periorbita. It is **loosely adherent to the bones**Q. It is **firmly adherent to** orbital margin, superior and inferior orbital fissures, the optic canal the lacrimal fossa and the sutures.

20. Ans. (b) Frontal ..., (c) Greater...

Ref: BDC 4/e, Vol. III p. 27; Khurana 6/e, p. 377; Khurana 5/e, p. 403; Gray's 40/e, p. 656

*"Lateral wall of the orbit is formed by the orbital surface of the **greater wing of the sphenoid posteriorly** & the **frontal process of the zygomatic bone anteriorly**"(Gray's 40th /656)*

21. Ans. (b) 3rd CN, (c) 4th CN, (d) 6th CN & (e) Lacrimal nerve

22. Ans. (c) Orbit

Ref: Khurana Anatomy 2/e, p. 493

It is a fascial expansion of the extraocular muscles formed by fusion of sheaths of MR, IR, LR, IO extending from the posterior lacrimal crest to the lateral orbital margin.

23. Ans. (a) Orbital varix

Ref: Yanoff and Ducker 2/e, p. 731-740, Kanski 6/e, p. 180-188

Proptosis from orbital varix is unilateral (most cases nonpulsalite and has no thrill or bruit. It is compressible and is characteristically precipitated by increasing venous pressure as in assuming a depending position (bending forwards). MRI may show echogenic shadows from phleboliths (venous stasis leads to formation of phleboliths).

- **Proptosis with neurofibromatosis** is not compressible and is not precipitated on increasing venous pressure and is pulsatile if associated with orbital roof fracture
- **Proptosis in Encephalocele** is reducible but not compressible and Echogenic shadows are not a characteristic feature
- **Proptosis in carotico-cavernous fistula** is pulsatile, associated with Bruit and Thrill and is not precipitated or aggrevated by increasing venous pressure

24. Ans. (a) Optic glioma

Ref. Kanski 7/e, chapter 3, Jakabisc 3/e, p. 2886

- Space-occupying lesions within the muscle cone, such as cavernous haemangiomas and optic nerve tumours cause axial proptosis.

25. Ans. (d) Neuroblastoma

26. Ans. (a) Breast

Ref: Yanoff 3/e Chapter 8.3 Metastatic cancer to the eye

- Metastasis is the most common intraocular malignant lesion.
- Most common intraocular site of metastasis is: Choroid.

27. Ans. (b) Chloroma

28. Ans. (c) Chloroma (Leukemia)

Ref: The Massachusetts Eye and Ear Infirmary review manual for Ophthalmology' by Jager, Lamkin (Lippncott Williams) 3/e, p. 159, 186 (Q19); Harley's pediatric ophthalmolgy' (Lippincott Williams and Wikins) 2005 p. 371

"The most common cause of bilateral proptosis in children is not definitively established, but, metastatic neuroblastoma and/or leukemia (chloroma) should be considered': The massachusetts Eye and Ear infirmary Review Manual for Ophthalmology' 3rd/Q19.

29. Ans. (d) Intra-arterial digital subtraction angiography

Ref: Kanski 7/e, p. 95, 96

History of trauma with proptosis, chemosis and ophthalmoplegia indicates carticocavernous fistula

- Investigations: CT and MR may demonstrate prominence of the superior ophthalmic vein and diffuse enlargement of extraocular muscles. The ultimate test, however, is selective arteriography of both internal and external carotid arteries.

30. Ans. (d) Carotid cavernous fistula

Ref: Parson 21/e, p. 499, Kanski 7/e, p. 95, 96

History of proptosis and pain following RTA is highly suggestive of carotid cavernous fistula.

31. Ans. (c) Cavernous sinus thrombosis

Ref: Parson's 20/e, p. 456-459;

Orbital apex syndrome and orbital cellulitis (MC cause-ethmoidal sinusitis), present with concurrent complete external ophthalmoplegic.

32. Ans. (a) Rhabdomyosarcoma

Ref: Kanski 8/e, p. 109, 497, Jakobiec 3/e, p. 2903 (Refer text)

33. Ans. (a) Arise..., (e) More...

Ref: Khurana 5/e, p. 421; Parson's 22/e, p. 495; Robbins 9/e, p. 1222; Harshmohan 7/e, p. 859; Nelson 19/e, p. 1761

34. Ans. (c) Non Hodgkin lymphoma

Ref: Jakobiec, 3/e, p. 3045

35. Ans. (b) Capillary hemangioma

Ref: Kanski 7/e, p. 103

36. Ans (a) Buphthalmos

Ref: Parson's 22/e, p. 484

37. Ans. (d) Inferior rectus

Ref: Kanski 7/e, p. 88

Elevation defect is caused earliest by fibrotic contracture of the inferior rectus.

38. Ans. (a) Proptosis and chemosis

Ref: Parson's 22/e, p. 452

39. Ans. (c) Cavernous hemangioma

Ref: Kanski 7/e, p. 105

Cavernous hemangioma occurs most commonly in adults with a female preponderance. Most frequently occur within the lateral part of the muscle cone just behind the globe.

40. Ans. (a) Ethmoidal

Ref: Dhingra 4/e, p. 182, 190, Jakobiec volume 3A 3/e, p. 2961

- Ethmoid sinusitis, the commonest cause of orbital cellulitis in all ages, results from septic thrombophlebitis of the valveless veins between the orbit and the sinuses.
- Bacteria are the commonest causes with staphylococci and streptococci being the most commonly inoculated organisms.

41. Ans. (c) Staphylococcus aureus

Refer previous answer

42. Ans. (b) Orbital apex

Ref: Kanski 7/e, p. 94

43. Ans. (a) Thyrotoxicosis

Ref: Kanski 8/e, p. 82

90% cases are due to associated Grave's disease.

44. Ans. (b) Cavernuos hemangioma

Ref: Kanski's 7/e, p. 105

- **Cavernous hemangioma** is the most common **benign, intraconal** tumour in adults.
- Presents with slowly progressive unilateral proptosis
- CT–well circumscribed oval lesion, encapsulated

Axial CT showing a well circumscribed retrobulbar intraconal oval lesion with proptosis

45. Ans. (c) Carotid cavernous fistula

Ref: Parson's 22/e, p. 499

46. Ans. (a) Retrobulbar space

Ref Jakobiec 3/e, p. 2886

Tumour lying in retro bulbar space (also called central space or muscle cone) produce axial proptosis.

47. Ans. (c) Elevation

Ref: Head and Neck Surgery 2/e, p. 1513

Most commonly muscle involved in thyroid ophthalmology is inferior rectus, which becomes fibrotic and thickened. Thus eyeball is depressed and elevation is not possible.

48. Ans. (a) Constricted pupil in response to light

Ref Clinical Ophthalmology 4/e, p. 786

- In CST, there is loss of direct and consensual light reflex on the same side (due to associated 3rd cranial nerve palsy). So there will be no pupillary constriction in response to light.
- Retinal veins are engorged and congested in later stages.
- Ptosis (due to 3rd nerve involvement) and ophthalmoplegia (due to 3rd, 4th, 6th nerve involvement) occur in CST.

49. Ans. (b) CSF rhinorrhea

Ref Dhingra 5/e, p. 213

50. Ans. (c) Sympathetic nerves

Ref. Gray's anatomy 40/e, p. 691

The palpebral fissures are widened in states of fear or excitement by contraction of the smooth muscle fibres of the superior tarsal (Müller's muscle) and inferior tarsal muscles, as a results of increased sympathetic activity. Lesions of the sympathetic supply result in drooping of the upper eyelid (ptosis) as seen in Horner's syndrome".

51. Ans. (b) Lipogranulomatous inflammation

Ref: Kanski 7/e p. 4

52. Ans. (a) Sebaceous cell carcinoma

Ref: Kanski 7/e, p. 21, 4

Sebaceous Gland Carcinoma

- Typically arises from meibomian glands or glands of Zeis[Q]
- Most frequently arises from the upper eylids[Q] where meibomian gland are most frequent (in contrast to basal cell and squamous cell carcinoma)
- Highly malignant with mortality of 5–10%
- Elderly females are typically affected.
- Nodular SGC masquerades a 'chalazion' and hence any patient with recurrent chalazion with an unusual consistency should undergo a full thickness resection and histological examination to exclude SGC.

53. Ans. (c) Inflammation of meibomian gland

Ref: Parson's 22/e, p. 452

54. Ans. (b) Associated with diplopia

Ref: Parson's 20/e, p. 435-38; Ptosis Surgery by Arnab Biswas 2010 p. 77-80; Nelson 18/e, p. 2584-85

55. Ans. (a) Levator resection

Ref: Kanski 7/e, p. 41

56. Ans. (d) Muller recession

Ref: Kanski 7/e, p. 43

- Resection–Strengthening procedure
- Recession–Weakening procedure

In ptosis, Muller's resection needs to be done as Muller's muscle is an eyelid elevator.

57. Ans. (a) Symblepharon

Ref: Parson's 22/e, p. 459

58. Ans. (b) From abnormal sites

Ref: Kanski 7/e, p. 27

59. Ans. (a) Squamous.., (b) Sebaceous.., (c) Malignant.. & (d) Basal..

Ref: Khurana 4/e, p. 359; Parson's 20/e, p. 439-40

Classification of Lid Tumors

- *Benign tumours*: These include; simple papilloma, naevus, angioma, haemangioma, neurofibroma and sebaceous adenoma.
- *Pre-cancerous conditions*: These are solar keratosis, carcinoma-in-situ and xeroderma pigmentosa.
- *Malignant tumours:* Commonly observed tumours include *squamous cell carcinoma, basal cell carcinoma, malignant melanoma and sebaceous gland adenocarcinoma.*

60. Ans. (a) Floor of orbit

Ref: Parson's 22/e, p. 486

Post-traumatic enophthalmos is caused by blow out fracture through the floor of orbit.

61. Ans. (a) Cavernous sinus

Ref: Yanoff and Duker 4/e, p. 984

62. Ans. (c) Chemotherapy and radiotherapy

Ref: Kanski 6/e, p. 200-201, Yanoff and Duker 4/e, p. 1321-1322

Rhabdomyosarcoma is the most common malignant orbital tumour in the paediatric age group.

Types:

- Embryonal – Most common
- Pleomorphic – Least common and Best prognosis
- Alveolar – Worst prognosis

Treatment involves combination of Radiotherapy and Chemotherapy

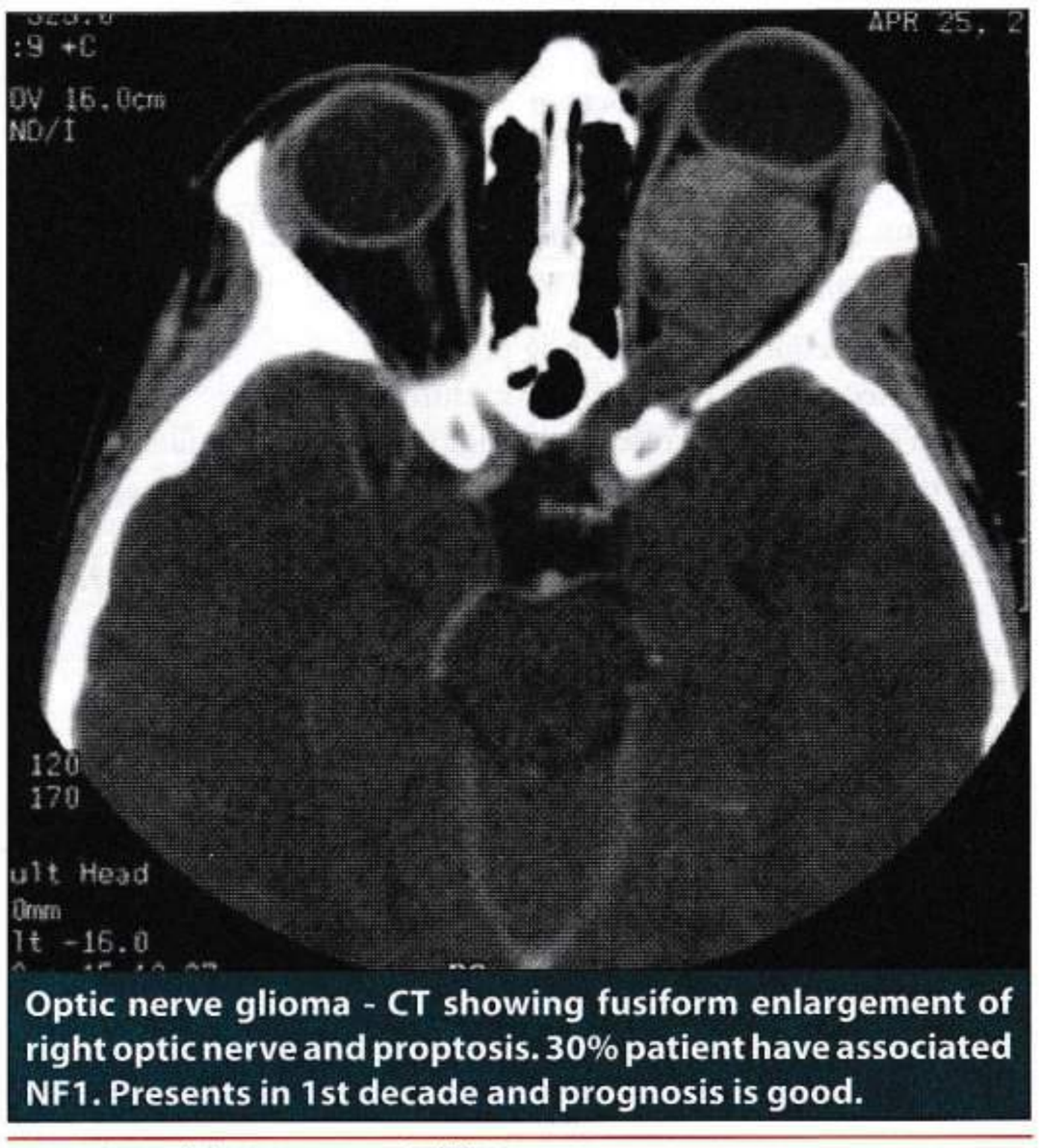
63. Ans. (d) Hodgkin's lymphoma

Ref: Yanoff and Duker 4/e, p. 1325

64. Ans. (d) Pilocytic

Ref: Sunita Agarwal, Vol. 2 p. 385; Kanski 7/e, p. 107

Most common type of optic nerve glioma is juvenile pilocytic astrocytoma, occurring most commonly in the first decade of life with Proptosis and visual dysfunction.



Optic nerve glioma - CT showing fusiform enlargement of right optic nerve and proptosis. 30% patient have associated NF1. Presents in 1st decade and prognosis is good.

65. Ans. (c) Damage.. & (d) Damage..

Ref: Khurana 4/e, p. 356: Ptosis Surgery by Arnab Biswas 2010 p. 77-80

- **Option a** – "The **Edinger-Westphal nucleus[Q] (also known as the accessory oculomotor nucleus)** is the accessory parasympathetic cranial nerve nucleus of the oculomotor nerve (cranial nerve III). It supplies preganglionic parasympathetic fibers to the eye, constricting the pupil, accommodating the lens, and convergence of the eyes (So no role in ptosis)"-
- **Option b** – "In facial nerve palsy, patient will be unable to close eye & on attempting to close eye, eyeballs turn up & out *(Bell's phenomenon)* [Q]"-*Dhingra 5/e, p. 106*
- **Option c** – Damage to sympathetic supply causes muller's muscle palsy–ptosis
- **Option d** – 3rd CN palsy – LPS palsy leads to ptosis

66. Ans. (a) Pleomorphic adenoma

Ref: Parson's 22/e, p. 474

67. Ans. (c) Mucormycosis

Ref: Kanski 7/e, p. 91, Parson's 22/e, p. 242

Mucormycosis often affects patients with **diabetic ketoacidosis** or immunosuppression.

68. Ans. (b) Meibomian gland

Ref: Parson's 22/e, p. 453

69. Ans. (b) Connected to the pterygoid venous plexus; (d) Pass through superior orbital fissure; (e) Empties into superior ophthalmic vein

Ref: Cunnigham's p. 968; Grays Basic anatomy, p. 476

Venous drainage of the orbit

Inferior Ophthalmic vein

- **Begins** near the region of orbital **floor** and **medial wall**
- Runs backward over the Inferior rectus and across the Inferior orbital fissure
- Either **joins the Superior ophthalmic vein** or **passes through superior orbital fissure** to drain into the cavernous sinus
- It communicates with the **Pterygoid venous plexus** and the facial vein
- Receives **tributaries** from
  - Inferior rectus and inferior oblique
  - Nasolacrimal duct
  - Eyelids
  - Two inferior Vortex veins

Superior Ophthamic vein

- **Forms** posteromedial to the upper eyelid
- **Connects** anteriorly with the Facial and supraorbital veins
- **Runs** with the **ophthalmic artery** and lying **between optic nerve** and **superior rectus**
- **Traverses** through the upper part of the superior orbital fissure.
- Receives **tributaries** from
  - Central retinal vein
  - Two superior vortex veins

Infraorbital nerve

- **Runs** in the **floor** of the orbit with the infraorbital artery and nerve

- **Passes** through the **inferior orbital fissure** into the **ptrygoid venous plexus**

70. Ans. (c) Prominence of lid crease

Ref: Khurana 6/e, p. 379; Kanski 7/e, p. 41

Refractive errors are common and more frequently responsible for amblyopia than the ptosis itself. Thus, the amblyopia is either anisometropic (if unilateral) or isoametropic (if bilateral) amblyopia, rather than being stimulus deprivation (which will occur in cases of complete ptosis).

71. Ans. (b) Tarsal glands are meibomian glands; (d) Meibomian glands are modified sebaceous glands; (e) External hordeolum is an acute suppurative inflammation of gland of Zeis

Ref: Khurana 6/e, p. 363; Kanski 8/e, p. 3

Meibomian glands are also known as tarsal glands, as they are present in the stroma of tarsal plate. They are modified sebaceous glands

Refer text for other options

72. Ans. (b) Has meibomian glands; (d) Acts as skeleton of eye

Ref: Khurana 6/e, p. 363; Parson's 22/e, p. 449-450

- **Tarsus** consists of dense fibrous tissue, but no cartilage
- It gives shape and firmness to the lid
- Embedded in tarsal plate are Meibomian (tarsal) glands, which open via straight ducts, anterior to the posterior margin of the intermarginal strip
- **Grey line** – divides lid into anterior lamina (skin and muscles) and posterior lamina (tarsal plate and conjunctiva). The spillting of eyelid when required is done at grey line

73. Ans. (a) Frontalis Suspension surgery

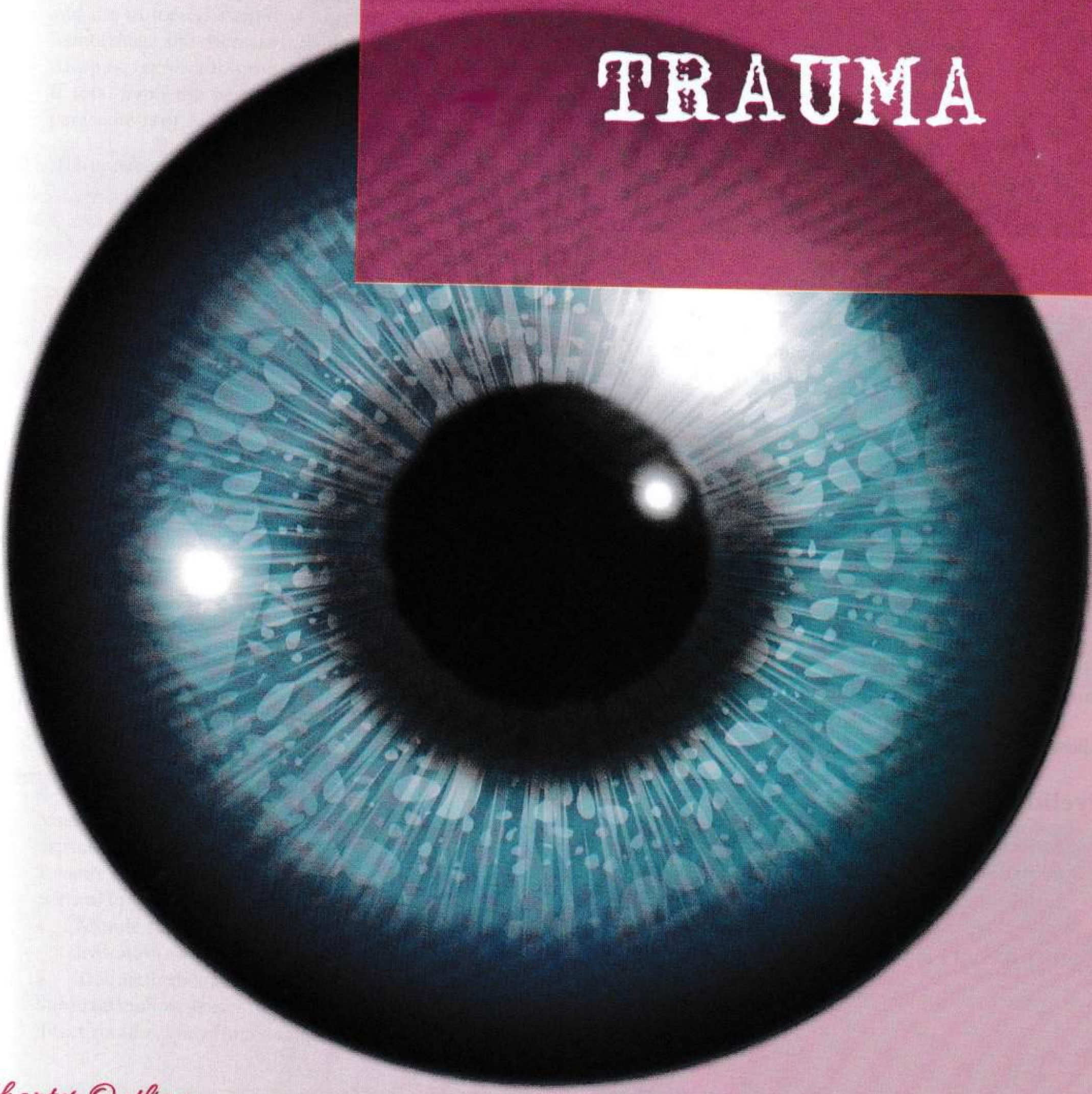
(Ref: Kanski 8/e, p. 45; Parsons 22/e, p. 464; Yanoff 4/e, p. 1273)

Brow (frontalis) suspension is used for severe ptosis (> 4 mm) with very poor levator function (< 4 mm) in simple congenital ptosis or occurring due to 3rd nerve palsy, blepharophimosis syndrome and following unsatisfactory previous LPS resection. The tarsal plate is suspended from the frontalis muscle using a sling made of either fascia lata or silicone/prolene

NOTES

11

TRAUMA



Chapter Outline

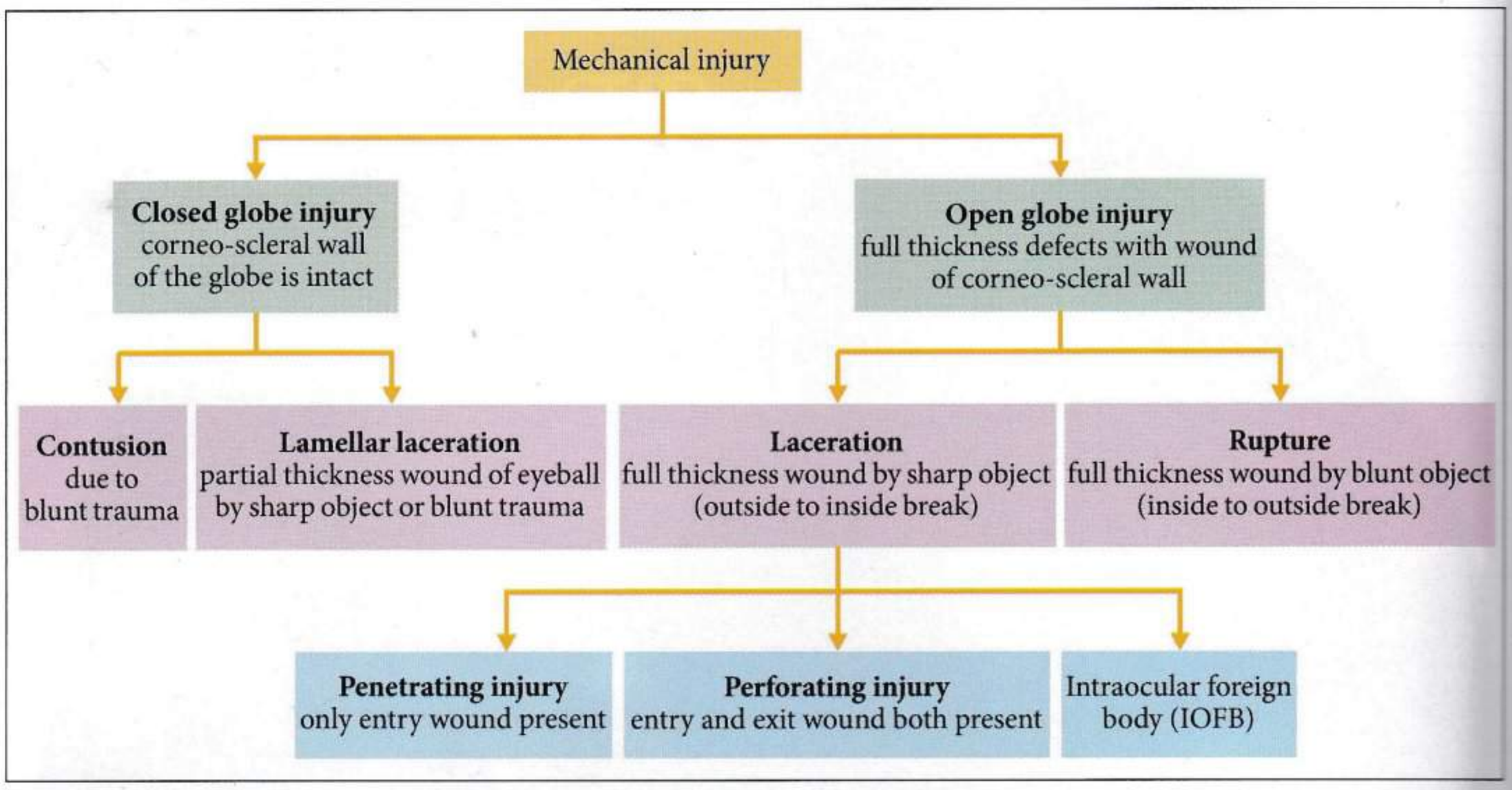
Mechanical Ocular Injuries

- Blunt Trauma
- Intraocular Foreign Body
- Orbital blow out Fracture

Chemical Injuries

MECHANICAL OCULAR INJURIES

Mechanical injuries to the globe may produce various sequelae, which have been classified under **BETTS classification** – (Birmingham Eye Trauma Terminology System)


Mechanical injury
Closed globe injury
corneo-scleral wall of the globe is intact
Open globe injury
full thickness defects with wound of corneo-scleral wall
Contusion
due to blunt trauma
Lamellar laceration
partial thickness wound of eyeball by sharp object or blunt trauma
Laceration
full thickness wound by sharp object (outside to inside break)
Rupture
full thickness wound by blunt object (inside to outside break)
Penetrating injury
only entry wound present
Perforating injury
entry and exit wound both present
Intraocular foreign body (IOFB)

Blunt Trauma

Blunt trauma usually occurs due to Tennis ball injury[Q], champagne cork, fist injuries, etc.

It results in antero-posterior compression of the globe with transverse equatorial expansion, which may result in the following conditions:

Eyelid

- Periocular hematoma
- Ecchymosis and edema

] Black eye

- Canalicular lacerations –should be repaired by use of CRAWFORD silicone tube or MINI-MONOKA stent.

Conjunctiva

Subconjunctival hemorrhage

Cornea

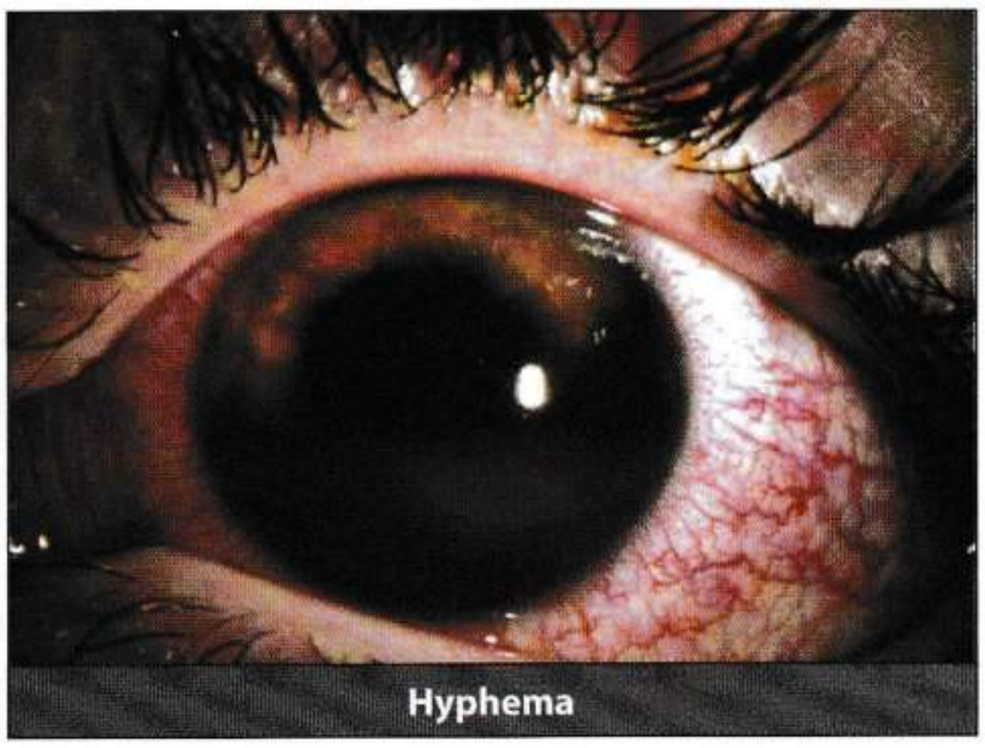
- Corneal abrasion – diagnosed on fluorescein staining
- Tears in Descemet membrane – vertical – usually due to birth trauma
- Acute stromal edema
- Blood staining of the cornea (methemoglobin in stroma) – due to hyphema – clears very slowly (2–3 years) from periphery towards cornea.

Hyphema

- **Most common[Q] manifestation** in blunt trauma
- Accumulation of blood in the anterior chamber due to hemorrhage from Circulus Iridis major[Q]
- Treatment[Q] involves elevating the head of the patient (45°) and use of topical steroids – to reduce the risk of secondary hemorrhage and decrease inflammation
  Atropine (mydriatics) use is controversial
  If total hyphema persists for more than 4 days – consider paracentesis or AC wash

8 ball hyphema

Total hyphema with dark red-black blood.
Black color suggests impaired aqueous circulation with decreased oxygenation. It carries higher risk of 2° ACG.



Hyphema

Pupil, Iris and Ciliary Body

- Initial transient miosis[Q] followed by traumatic mydriasis due to iris sphincter (pupillae) damage
- Rupture/radial tear in pupillary margin
- **Iridodialysis**[Q] – detachment of the root of iris[Q] from its ciliary body attachment

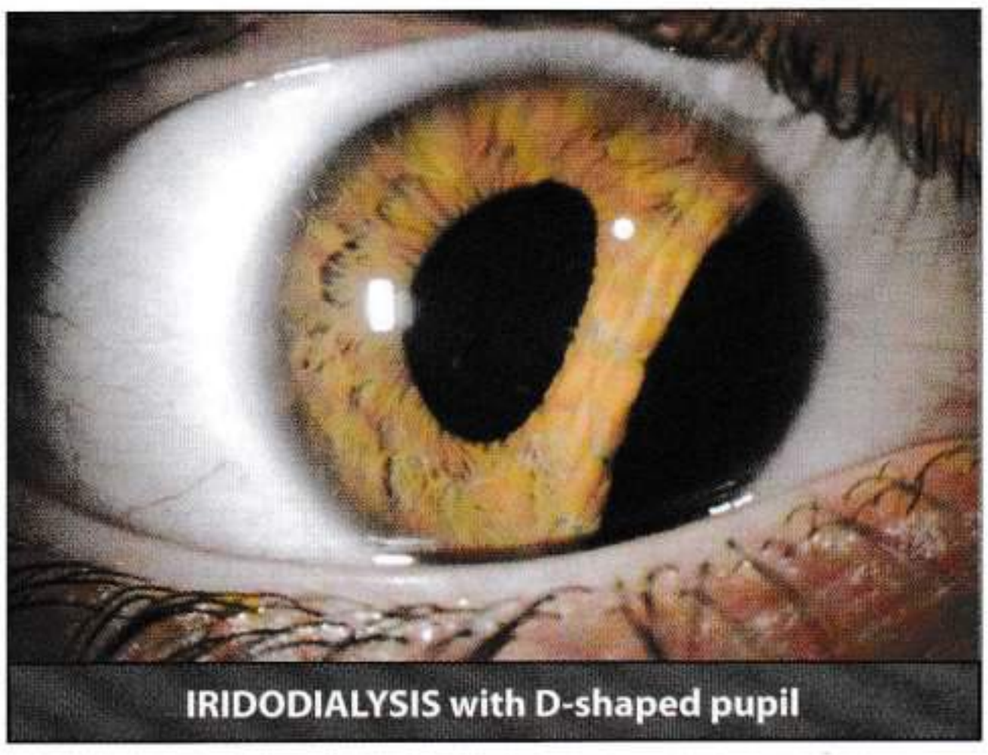
↓

forms a 'D' – shaped pupil[Q]

↓

may cause Monocular Diplopia

- Antiflexion of iris and traumatic aniridia may occur rarely
- **Angle recession**[Q] – due to rupture of ciliary body near its anterior attachment – 6-9% may develop glaucoma (2° OAG)
- **Iridodonesis** – tremulousness of iris



IRIDODIALYSIS with D-shaped pupil

Lens

- **Vossius ring**[Q] – imprint of a miotic pupil on the anterior capsule[Q] of lens
- **Rosette shaped cataract**[Q] – a posterior[Q] subcapsular/posterior cortical opacity, due to
  - Minute ruptures in lens capsule with influx of aqueous → hydration → opacification
  - Traumatic damage to lens fibers
- **Subluxation[Q] of lens** – with lens movement in direction of intact zonules/away from zonular dialysis

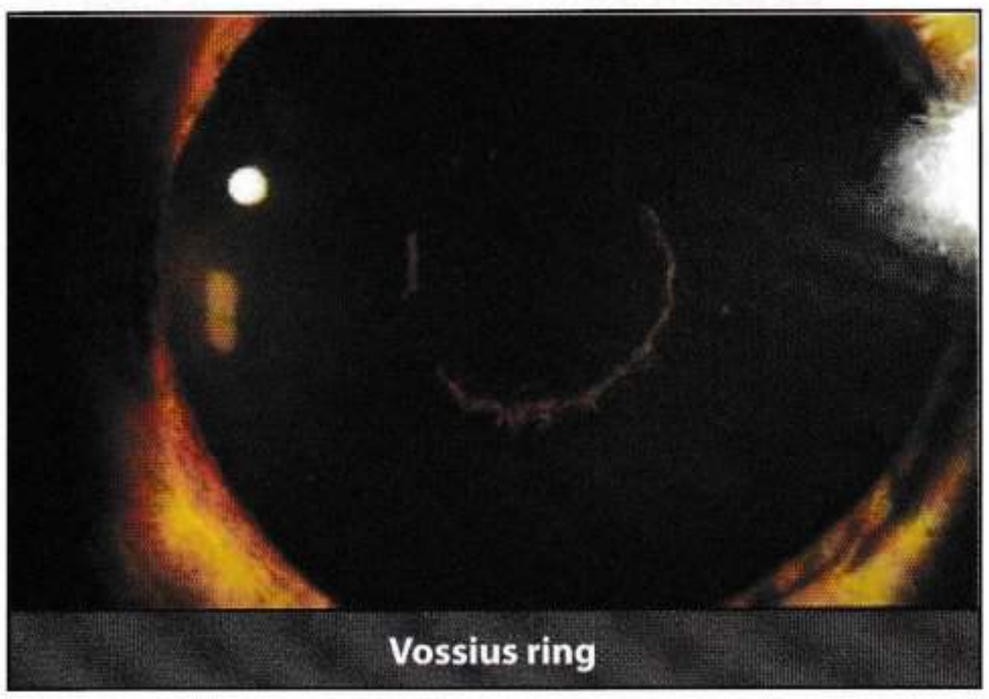
↓

May lead to Monocular diplopia and astigmatism

↓

Associated with Iridodonesis and Phacodonesis
(trembling of iris and lens with ocular movement)

- Dislocated lens[Q] – most commonly posteriorly into the vitreous – due to complete (360°) zonular fiber rupture



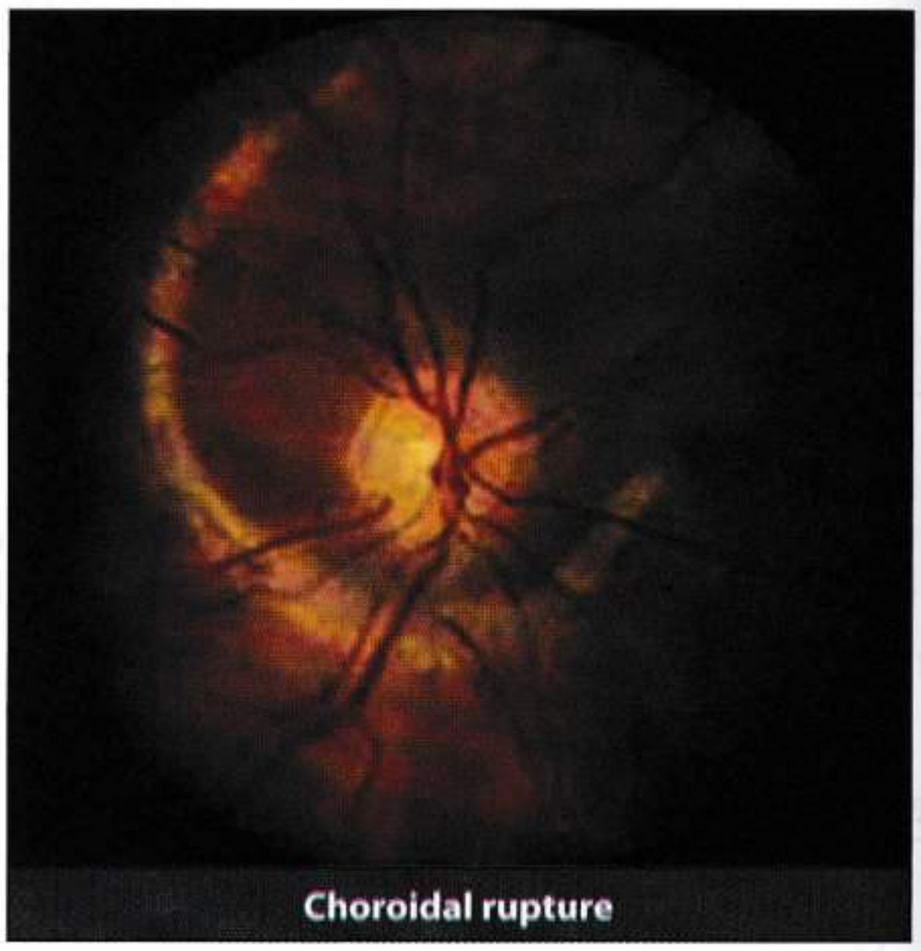
Vossius ring

Posterior Segment

- Vitreous hemorrhage[Q] and vitreal pigmentary opacities
- **Commotio retinae**[Q] – occurs at the Posterior pole[Q], due to edema **(Berlin's edema)**[Q] causing a grey white cloudy swelling. A **Cherry Red spot**[Q] is seen if macula is involved.
- Progressive pigmentary degeneration and **macular hole**[Q] formation may occur
- Retinal breaks (superonasal dialysis) and rhegmatogenous retinal detachment associated with avulsion of vitreous base – gives rise to '**Bucket – Handle** appearance' – Pathognomonic for previous blunt trauma
- **Choroidal rupture**
  - Direct – anteriorly along ora serrata
  - Indirect – opposite to site of impact
  - Rupture is visible as a curved white streak, temporally concentric to the optic disc
  - May lead to choroidal neovascularization (CNV)
- **Traumatic optic neuropathy:** Only perception of light, with RAPD/AAPD being only clinical sign present.

  Spontaneous visual improvement occurs in most patients. **Steroids offer no benefit**–international optic nerve trauma[Q] study.

  Optic canal decompression-limited use (delayed visual loss or vision doesnot improve over 4 days).



Choroidal rupture

Extra Mile

- Vitreous hemorrhage due to trauma, surgery or retinal disease may lead to **ghost cell glaucoma** – degenerated RBC's (khaki colored) enter the AC and collect inferiorly creating a pseudohypopyon and clogging the trabecular meshwork.
- 'CANDY STRIPE SIGN' is characteristic in severe cases

Rupture of the Globe

- An open globe injury – inside to out tear∧
- Caused by fall upon a projecting object like a knob or a key
- **Site of rupture** – In the vicinity of **Schlemm's canal**[Q], usually Superonasal limbus[Q] and sclera – 3 mm posterior to LIMBUS
- Causes ocular hypotony (↓IOP)
- Scleral ruptures are usually repaired with 8 – O nylon sutures
- Patching should not be done in Blunt trauma – rupture[Q].

Intraocular Foreign Body (IOFB)

IOFB may complicate a penetrating injury if RETAINED inside the eyeball.
IOFB may be classified as

- TOXIC
  - Metallic Iron/Steel/Nickel Copper/Aluminium/ Mercury/Zinc
  - Non-metallic vegetative material
- INERT
  - Metallic Gold, Silver, Platinum
  - Non-metallic Carbon, stone, porcelain, rubber

Minute chips of iron and steel are the **most common** IOFB[Q]

Modes of Damage

- Mechanical effects – depends upon size and velocity of FB
- Introduction of infection
  - Metallic FB are usually sterile – due to heat generated on their emission
  - Pieces of wood or stone carry a greater chance of infection ending usually in endophthalmitis
- Reactions to a FB
  - Inert FB – no reaction
  - Lead & Aluminium – cause fibrosis
  - Zinc, copper, mercury, aluminium (Toxic non-metallic FB) – incite suppuration
  - Siderosis – degenerative changes by Iron FB, due to electrolytic dissociation and dissemination
    - Earliest sign – deposition in anterior capsule of lens appearing as a rusty ring – pathognomonic
    - Heterochromia iridis – Hyperchromic
    - Visual loss due to pigmentary retinal dystrophy
    - Secondary chronic glaucoma
    - Diagnosed by – Prussian blue reaction
  - Chalcosis – copper from an alloy (not pure copper) deposited on membranous structures
    - Kayser-Fleischer Ring – deposition in Descemet's membrane in Wilson's disease
    - Sunflower cataract
    - No degenerative changes – so visual prognosis is good
  - Caterpillar hair produces granulomatous iridocyclitis known as **Ophthalmia Nodosa**[Q]

Management

- CT scan is the investigation of choice for metallic FB
- MRI is contraindicated for metallic (Iron) FB
- Magnetic removal of magnetized FB
- Forceps removal ± pars plana vitrectomy for non-magnetic FB

- In penetrating trauma, patching should be done as the first-line treatment.
- SEIDEL's test – used to locate the entry wound in a penetrating injury by use of fluorescein dye.

Orbital Fractures

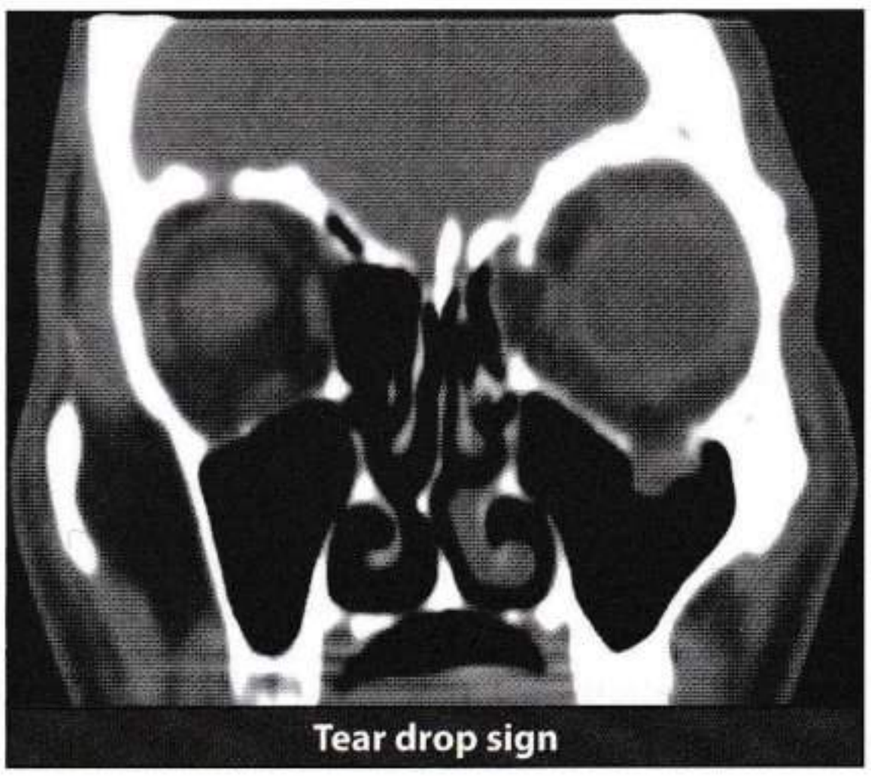
Blow Out Orbital Fracture

- Usually caused by a sudden increase in orbital pressure due to an object (fist/tennis ball), where object diameter is greater than diameter of orbital aperture
- Blow out fracture usually **involves the FLOOR of orbit**[Q]

Pure blow out fracture
does not involves orbital rim; only floor gets fractured

Impure blow out fracture
involves the orbital rim and/or adjacent facial bones

- Signs
  - Periocular ecchymosis, edema, etc.
  - Infraorbital nerve anesthesia
  - Double diplopia – occurs due to mechanical entrapment of both inferior rectus and inferior oblique muscles
  - Enophthalmos – sunken eyeball
  - X-ray (Water's view) - 'Tear drop' sign is seen in the antrum



Tear drop sign

EXTRA MILE

X-ray views of orbit

- Caldwell-luc view:
  - PA view
  - Occipitofrontal
  - Structures seen:
    - Superior orbital fissure
    - Greater and lesser wing of sphenoid
    - Ethmoid and frontal sinus
    - Floor of sella
- Town's view:
  - AP view
  - Fronto-occipital

Orbital Roof Fracture

- Occur due to blow on brow or forehead
- Presents with **panda/racoon** eyes
- DO NOT blow nose in case of orbital floor fracture

PANDA/RACOON eyes

CHEMICAL INJURIES

Chemical injuries to the ocular surface are an ocular emergency as they lead to early visual impairment and disfigurement.

The main cause is industrial accidents.

ETIOLOGY

They may occur due to

Alkalis	Acids
• Ammonia, Sodium hydroxide, Lime[Q] • Act by saponification of fatty acids of cell membranes causing necrosis[Q] ↓ Penetrate deeper[Q] • Twice as common	• Hydrochloric acid Sulphuric acid • Act by precipitating the proteins and causing coagulation[Q], thus ↓ Do not penetrate[Q] • Less common Exception is hydrofluoric acid which penetrates cornea rapidly

SIGNS

Necrosis of the conjunctival and corneal epithelium within seconds with occlusion of limbal vasculature

↓

Conjunctivitis and chemosis with limbal ischemia and corneal haze (may remain clear)

↓

Limbal stem cell loss leads to persistent corneal epithelial defects and conjunctivalization of corneal surface

↓

Long term – symblepharon and entropion may occur
AC penetration results in iris and lens damage with hypotony

CLASSIFICATION

Roper Hall Classification of Ocular Surface Burns

Grade	Prognosis	Cornea	Conjunctiva/Limbus
I	Good	Corneal epithelial damage	No limbal ischemia
II	Good	Corneal haze, iris details visible	<1/3 limbal ischemia
III	Guarded	Total epithelial loss, stromal haze, iris details obscured	1/3–1/2 limbal ischemia
IV	Poor	Cornea opaque, iris and pupil obscured	>1/2 limbal ischemia

Dua Classification for Ocular Surface Burns

Grade	Prognosis	Clinical findings	Conjunctiva involvement	Analogue scale
I	Very good	0 clock hours of limbal involvement	0%	0/0%
II	Good	<3 clock hours of limbal involvement	<30%	0.1–3/1–29.9%
III	Good	Between 3 and 6 clock hours of limbal involvement	30–50%	3.1–6/31–50%
IV	Good to guarded	Between 6 and 9 clock hours of limbal involvement	50–75%	6.1–9/51–75
V	Guarded to poor	Between 9 and 12 clock hours of limbal involvement	75–100%	9.1–11.9/75.1–99.9%
VI	Very poor	Total limbus (12 clock hours) involved	Total conjunctiva (100%) involved	12/100%

Treatment

- Copious early irrigation with normal saline and removal of all foriegn particles by double eversion of the eyelid to normalize the pH and reduce the duration of contact of chemical – most important prognostic factor and a thorough slit lamp examination should be done – IMMEDIATE treatment

Early acute phase treatment

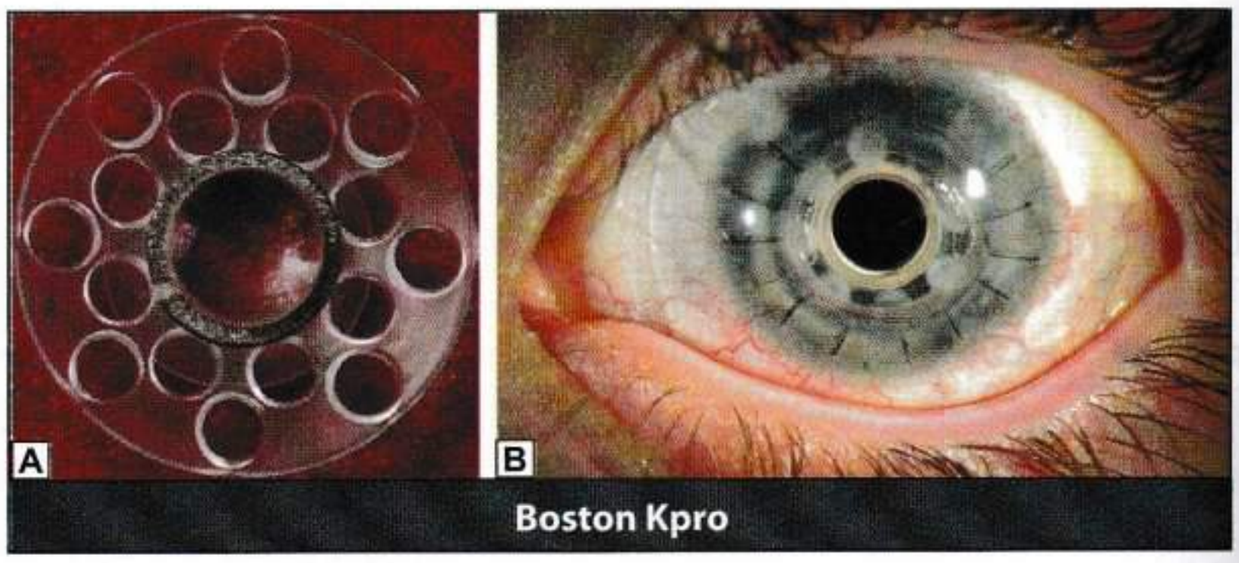
MEDICAL treatment

Topical antibiotics ↓ To prevent superinfection	Cycloplegic agents ↓ Atropine or cyclopentolate for comfort	Lubricating eye drops (preservative free)	Topical sodium citrate 10% - 2 hourly ↓ Reduce proteolytic activity by chelation	Topical steroids ↓ For initial 7–10 days ↓ Pred acetate 1% QID	Topical ascorbic acid (10%) hourly + systemic vitamin C – 2 g QID ↓ Improves wound healing by promoting collagen synthesis	Doxycycline ↓ Inhibit MMPs

Surgical treatment - Intermediate and late treatment usually needed for GIII and GIV injuries

Amniotic membrane transplantation (AMT) promotes epithelization and reduces lid friction - due to expression of TGβ 1 and EGF	Limbal stem cell transplantation autograft or allograft (if bilateral injury)	Tenoplasty advancement of conjunctiva and Tenon's capsule to limbus	Keratoplasty or Boston prosthesis

Limbal ischemia with corneal haze



Boston Kpro

IMAGE-BASED QUESTIONS

Question number 1 is based on Image 1.

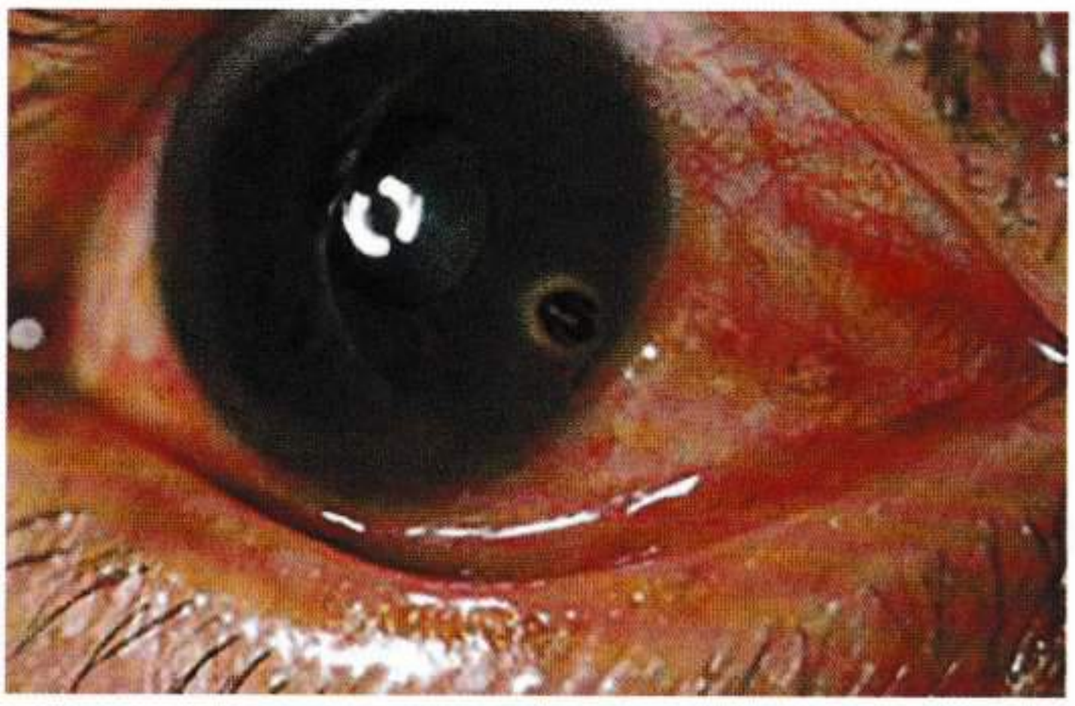


Image 1

1. **A 25-year-old male, welder by profession, presents with complaints of redness, pain and irritation since morning. On examination, the findings in the below image are seen. What is the best line of management?**
   a. Deep anterior lamellar keratoplasty
   b. Topical antibiotics and steroids
   c. Removal with a 26 gauge needle
   d. Copious saline irrigation

Most Recent Image-Based Questions of 2019-2017

Question number 2 is based on Image 2.

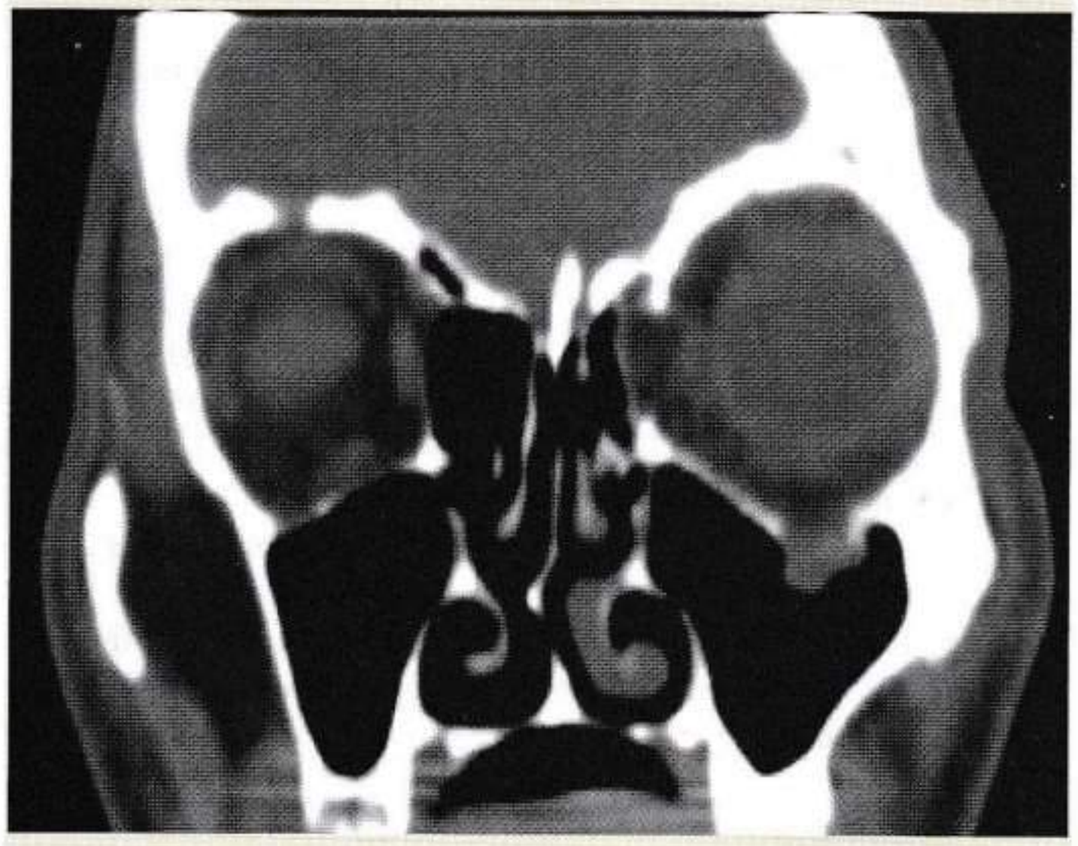


Image 2

2. **A patient presented with diplopia and restricted ocular movements. CT scan shows the image given below. What is the most probable cause?** *(Recent question Jan 2019)*
   a. Le-fort fracture
   b. Blow out fracture of orbit
   c. Zygomatic fracture
   d. Orbital rim fracture

MULTIPLE CHOICE QUESTIONS

3. **Betts classification is used for** *(Recent pattern Nov/Dec 2016)*
   a. Ocular Trauma
   b. Retinopathy
   c. Corneal Ulcers
   d. Uveitis
4. **An 18-year-old boy comes to the eye casualty with history of injury with a tennis ball. On examination there is no perforation but there is hyphema. The most likely source of the blood is** *(All India 2005)*
   a. Iris vessels
   b. Circulus iridis major
   c. Circulus iridis minor
   d. Short posterior ciliary vessels
5. **Vossius ring is seen in?**
   a. Episcleritis
   b. CRAO
   c. Blunt trauma
   d. Penetrating trauma
6. **On fundoscopic examination of a patient, a red dot is seen. He has a history of being hit by a tennis ball. What is the probable cause?** *(AIIMS May 2012)*
   a. Macular hole
   b. Berlin's edema
   c. Macular tear
   d. Macular bleed
7. **A young boy presents to the ophthalmology department with decreased vision, six months after being hit by a tennis ball in the eye. Which of the following findings on optical examination is suggestive of Blunt injury to the eye?** *(All India 2011)*
   a. Optic Neuritis
   b. Pars Planitis
   c. Vitreous base detachment
   d. Equatorial edema
8. **Cherry red spot after trauma is seen in children due to** *(AIIMS May 2015)*
   a. CRAO
   b. CRVO
   c. Berlin's edema
   d. Niemann-Pick's disease
9. **Blunt injury to eye causes recession of angle of the eye because of?** *(Recent pattern 2013)*
   a. Tear of the ciliary body
   b. Schlemm canal split
   c. Trabecular meshwork split
   d. Dislocation of the lens
10. **D Shaped pupil is seen in** *(Recent pattern Nov/Dec 2016)*
    a. Iridodialysis
    b. Iridodonesis
    c. Anterior uveitis
    d. Blunt trauma
11. **Investigation of choice for intraocular foreign body is** *(Recent pattern Nov/Dec 2016)*
    a. CT Scan
    b. MRI
    c. USG
    d. X-ray
12. **Which of the following is an inert metal that can be left alone in eye?** *(DNB 2011)*
    a. Iron
    b. Copper
    c. Lead
    d. Nickel

Most Recent Image-based Questions of 2019-2017 are given at the end

13. **A child of 14 yr age, met with traumatic hyphema in right eye. Which of the following should not be used in management?** *(PGI May 2012)*
    a. Elevation of head end of bed
    b. Prednisolone
    c. Phenylephrine is very effective
    d. Carbonic anhydrase inhibitor
    e. Tropicamide
14. **Blow out fracture of orbit most commonly leads to fracture of**
    a. Medial wall
    b. Floor
    c. Roof of orbit
    d. Lateral wall
    e. Anterior wall
15. **Most common cause of fracture of roof of orbit –** *(AIIMS May 09)*
    a. Blow on back of head
    b. Blow on parietal bone
    c. Blow on the forehead
    d. Blow on the upper jaw
16. **True about blow out fracture of the orbit is** *(Recent pattern 2013)*
    a. Involve roof of orbit
    b. Downward gaze difficult
    c. Enophthalmos
    d. Supraorbital nerve anesthesia
17. **Which orbital bone is most likely to fracture with blunt trauma to the eye?** *(DNB 2012)*
    a. Zygomatic
    b. Orbital surface of Maxilla
    c. Ethmoid
    d. Sphenoid
18. **Ammonia exposure in eye, treatment is**
    a. Anesthetic + saline eye washes
    b. Call expert ophthalmologist
    c. Slit microscopy and cleaning
    d. Antibiotic drops
19. **A patient gives a history of chuna falling into his eyes. All of the following would be a part of his immediate management except:** *(AIIMS 2014)*
    a. Frequent instillation of Na citrate drops
    b. Irrigation of both eyes with copious amount of normal saline
    c. Thorough slit lamp examination
    d. Removal of chuna particles by double eversion of upper eyelid
20. **Association of intraocular hemorrhage with subarachnoid hemorrhage is known as** *(Recent pattern 2013-2014)*
    a. Terson's Syndrome
    b. Duane's Syndrome
    c. Brown's Syndrome
    d. Tolosa Hunt Syndrome
21. **Ischemic necrosis in alkali burn is seen in which clinical stage** *(Recent pattern Nov/Dec 2016)*
    a. Stage I
    b. Stage II
    c. Stage III
    d. Stage IV
22. **Copper foreign body in the eye, which of the following will be seen– C13**
    a. Cataract resembling petals of flower
    b. Fleischer ring
    c. Open angle glaucoma
    d. Pigmentary degeneration of retina
23. **Which is the best investigation to monitor vision in a patient with history of trauma to the right eye with an iron foreign body?**
    a. Serial Arden Ratio
    b. Serial ERG
    c. Serial VEP
    d. Serial Perimetry
24. **A 38-year-old woman had a left iron intraocular foreign body removed one year ago. Her current visual acuity was 6/6 in the right eye and 6/60 in the left. She is at risk of developing all of the following except**
    a. Miosis
    b. Cataract
    c. Open angle Glaucoma
    d. Optic atrophy
25. **What is the most important sign of Globe rupture due to blunt trauma?**
    a. Chemosis
    b. Hypotony
    c. Proplapse of iris
    d. Haemorrhage
26. **Racoon eyes are seen in fracture of which paet of the orbit?** *(Recent pattern Dec 2016)*
    a. Orbital roof
    b. Orbital floor
    c. Medial wall
    d. Lateral wall
27. **Hyphema is** *(Recent pattern Dec 2016)*
    a. Collection of pus in the anterior chamber
    b. Seen in cases of Behcet disease uveitis
    c. Collection of blood in the anterior chamber
    d. Collection of cells in the anterior chamber
28. **Blow out fracture of orbit involves** *(Recent pattern Dec 2016)*
    a. Medial wall
    b. Superior wall
    c. Inferior wall
    d. All the walls
29. **A case of injury to right brow due to a fall from scooter presents with sudden loss of vision in the right eye. The pupil shows absent direct reflex but a normal consensual pupillary reflex is present. The fundus is normal. The treatment of choice is:**
    a. Intensive intravenous corticosteroids as prescribed for spinal injuries to be instituted within six hours
    b. Pulse methylprednisolone 250 mg four times daily for three days
    c. Oral predinisolone 1.5 mg/kg body weight
    d. Emergency optic canal decompression
30. **Blow out fracture of orbit most commonly involves:** *(Recent pattern 2017)*
    a. Lateral wall
    b. Medial wall
    c. Floor
    d. Roof

Most Recent Questions of 2019-2017

31. **Ophthalmologic examination of a patient shows 'Vossius ring'. It is characteristic for which of the following condition** *(Recent question June 2018)*
    a. Penetrating injury
    b. Concussion injury
    c. Lens dislocation
    d. Extracapsular extraction

Most Recent Questions of 2019-2017 are given at the end

ANSWERS TO IMAGE-BASED QUESTIONS

1. Ans. (c) Removal with a 26 gauge needle

In the image a ferrous (iron) foreign body can be seen impacted within the cornea – which is consistent with an occupational hazard in a welder.

Option b – The best treatment would be removal of the foreign body with the help of a 26 gauge needle – with the bevel pointing away from the cornea, as if the foreign body is allowed to remain, there is increased risk of secondary infection and corneal ulceration.

Option a – Keratoplasty is not required for impacted foreign bodies or in corneal tears which may be sutured using a 10-0 nylon suture – first suture applied at/near the limbus.

Option d – also need to be done to remove any other foreign body particles in the fornix.

Option b – antibiotics need to be given after removal of the foreign body to prevent superinfection, but steroids should not be given as they impair epithelial healing.

2. Ans. (b) Blow out fracture of orbit

Ref: Parson's 22/e, p. 500

ANSWERS TO MULTIPLE CHOICE QUESTIONS

3. Ans. (a) Ocular Trauma

Ref: International society of Ocular Trauma Official Website

'Betts' in the betts classification refers to 'Birmingham Eye Trauma Terminology System'.

4. Ans. (b) Circulus iridis major

Ref: Ocular trauma principles and practice 5/e, p. 468

5. Ans. (c) Blunt Trauma

Ref. Khurana 4/e, p. 405

Refer text

6. Ans. (b) Berlin's edema

Ref: Khurana 5/e, p. 434

Refer text

7. Ans. (c) Vitreous base detachment

Ref: Complications in ophthalmic surgery' by Rosenberg (Mosby) 1999, p. 354

8. Ans. (c) Berlin's edema

Refer previous questions

9. Ans. (a) Tear of the ciliary body

Ref. Kanski 7/e, p. 880-881

Tears extending into the face of the ciliary body (angle recession) are associated with a risk of later glaucoma.

10. Ans. (a) Iridodialysis

Ref: Kanski 7/e, p. 880

D shaped pupil occurs due to dehiscenece of root of iris from the ciliary body, which occurs due to trauma, thus, Iridodialysis is the better answer.

11. Ans. (a) CT Scan

Ref: Current trends in the management of intraocular foreign bodies. Curr Opin Ophthalmol. 2008 May;19(3): 225–33

12. Ans. (c) Lead

Refer text

13. Ans. (c) Phenylephrine is very effective

Ref: Khurana 4/e, p. 199-200,404; Parson's 20/e, p. 118; L & B 25/e, p. 625, 650; emedicine.medscape. com/article/1190165-overview; KDT 6/e, p. 127,111

Phenylephrine is a very short acting mydriatic thus not effective.

14. Ans. (a) Medial wall & (b) Floor

Ref: Parson's 20/e, p. 468; Kanski 6/e, p. 848

"Most commonly the orbital floor[Q] 'blows out', but it can also affect the medial wall[Q] of the orbit"- Parson 20/e, p. 468

"Since the bones of lateral wall & the roof are usually able to withstand such trauma, the fracture most frequently involves the floor of orbit along the thin bone covering infraorbital canal" -Kanski 6/e, p. 848

15. Ans. (c) Blow on the forehead

Ref: Pediatric Ophthalmology 4/e, p. 446

Orbital roof fracture should be suspected in any child presenting with blunt injury to the brow or forehead with subsequent development of a hematoma of the upper lid in the hours following injury.

16. Ans. (c) Enophthalmos

Ref. Khurana 4/e, p. 399, Kanski 7/e, p. 873

17. Ans. (b) Orbital surface of Maxilla

Most common fracture is of the floor which is formed by the orbital surface of maxilla.

18. Ans. (a) Anesthetic + saline eye washes

Ref: Parson's 21/e, p. 373, 374

Refer text

19. Ans. (a) Frequent instillation of Na citrate drops

Ref: Kanski 7/e, p. 892-893

Chuna [$Ca(OH)_2$] is a form of alkali. Na citrate may be given but only in later stages, not an immediate treatment method.

20. Ans. (a) Terson's Syndrome

Ref: Kanski 8/e, p. 722, 92, 766

Association of intraocular hemorrhage with subarachnoid hemorrhage is known as Terson's Syndrome.

Terson's syndrome

- Terson's syndrome is the oculocerebral syndrome of intraocular hemorrhage in association with subarachnoid Hemorrhage
- Most commonly results from aneurysmal rupture (subarachnoid hemorrhage)
- Most commonly arises from the anterior communicating artery
- Most commonly is bilateral
- Intraocular Hemorrhage may be Vitreous or Retinal in location

Terson syndrome originally was defined by the occurrence of vitreous hemorrhage in association with subarachnoid hemorrhage. Terson syndrome now encompasses any intraocular hemorrhage associated with intracranial hemorrhage and elevated intracranial pressures. Intraocular hemorrhage includes the development of subretinal, retinal, preretinal, subhyaloid or vitreal blood. 'It is typically intraretinal and/or preretinal although occasionally subhyaloid blood may break into the vitreous'– Kanski

- Vitreous hemorrhage usually resolves spontaneously within a few months
- The long-term visual prognosis is good in the majority

21. Ans. (a) Stage I

Ref: http://www.dos-times.org/pulsar9088/20140622164942531.pdf

Clinical course can be divided into three stages:

- Acute stage – immediate to one week (Stage I) - in this stage there are signs in conjunctiva (edema, congestion, necrosis, copious discharge), cornea (sloughing, edema and opacity) and iris (iridocyclitis) with limbal ischemia.
- Reparation stage – one to three weeks (Stage II) - conjunctival and corneal epithelium regenerate, and there is corneal neovascularization.
- Late stage ansd sequelae – more than three weeks (Stage III): symblepharon, recurrent corneal ulceration, complicated cataract, secondary glaucoma in Grade III/IV burns, whereas Grade I/II burns heal completely with a good prognosis.

22. Ans. (a) Cataract resembling petals of flower

Ref: Parson's 21/e, p. 259

23. Ans. (b) Serial ERG

In early Siderosis, the ERG shows increased a-wave with normal b-wave. As the condition progresses, the b-wave diminishes and in advanced cases the ERG is flat.

24. Ans. (a) Miosis

The patient has Siderosis, left eye trauma with iron foreign body.

Siderosis damages the ocular structures mainly through the toxic effects of iron on the epithelium. In siderosis, the following signs may be seen:

- Mydriasis due to damage of the sphincter muscle – option a
- Glaucoma from damaged trabecular meshwork – option c
- Cataract from iron deposition – option b
- Pigmentary changes in the retina with attenuation of the vessels and optic atrophy – option d.

25. Ans. (b) Hypotony

Hypotony is the most important sign to diagnose a case of globe rupture.

Most common site of globe rupture is the Superonasal Limbus.

26. Ans. (a) Orbital roof

Ref: Kanski 7/e, p. 872

27. Ans. (c) Collection of blood in the anterior chamber

Ref: Kanski 7/e, p. 879

28. Ans. (c) Inferior wall

Ref; Kanski 7/e, p. 873

Blow out fracture is typically of the orbital floor, it may also involve the medial wall but always as a secondary involvement.

29. Ans. (d) Emergency optic canal decompression

Absent DLR with normal CLR indicates optic nerve injury and hence the best course of management is to decompress the orbital cavity immediately to save the nerve.

30. Ans. (c) Floor

Ref: Kanski 7/e, p. 873-875

31. Ans. (b) Concussion injury

Ref: Parsons's 22/e, p. 389

12

CONJUNCTIVA

Chapter Outline

Anatomy
- Parts
- Glands
- Histology
- Lymphatic Drainage
- Nerve Supply

Conjunctivitis
- Symptoms
- Signs

Bacterial Conjunctivitis

Viral Conjunctivitis

Chlamydial Conjunctivitis
- Trachoma
- Ophthalmia Neonatorum

Allergic Conjunctivitis

Miscellaneous Conjunctivitis

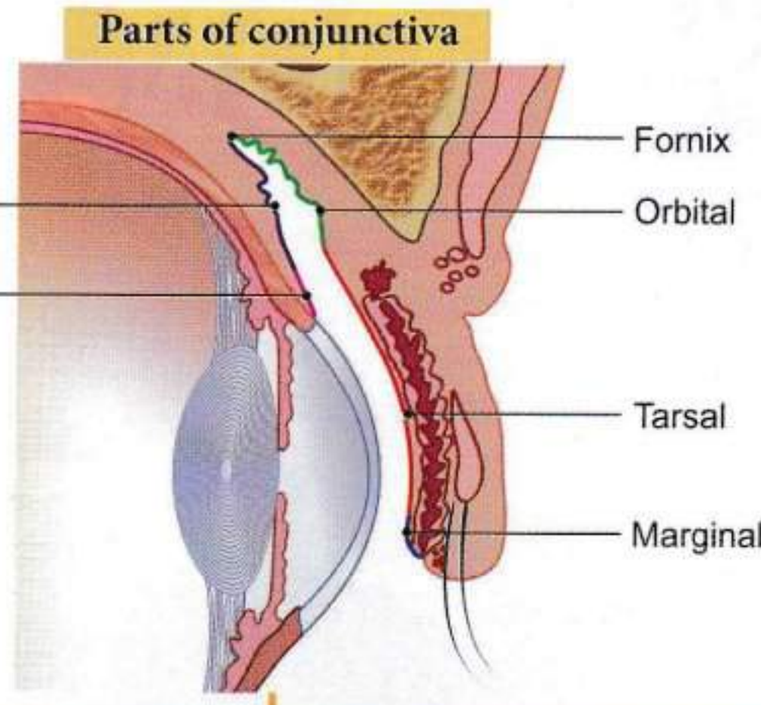
Conjunctival Degenerations

"Gulabi Ankhein Jo Teri Dekhein, Meri Bhi Gulabi Ho Gayi"

ANATOMY

Conjunctiva is a transparent mucous membrane lining the posterior (inner) surface of the eyelids and the anterior surface of eyeball.

Parts



Palpebral
- Lines the posterior surface of the eyelids
- Firmly adherent[Q] to the underlying structure
  - **Marginal**: extends from mucocutaneous junctions of the lid margin to about 2 mm posteriorly up to Sulcus subtarsalis[Q]
  - **Tarsal**
  - **Orbital**

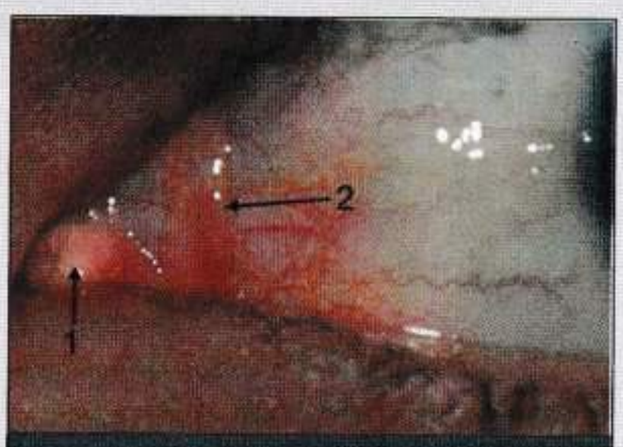
Forniceal
- Lines the cul-de-sac/ folds uniting the palpebral and bulbar conjunctiva

Bulbar
- Lines the anterior surface of sclera up to LIMBUS
- Freely movable
- Separated from sclera by episcleral tissue and tenon capsule
  - **Scleral**
  - **Limbal**: 3 mm around limbus; In this area conjunctiva, tenon's, episclera are fused

HIGH YIELD

- Marginal conjunctiva represents a transitional zone between skin and conjunctiva proper
- **Sulcus subtarsalis** is a common site for foreign body lodgment
- **MARX'S LINE** – A physiological line of vital dye stainable conjunctival epithelium just posterior to the mucocutaneous junction
- **Follicular and papillary conjunctional responses – most commonly occur in the Tarsal conjunctiva**
- Orbital conjunctiva has shallows and grooves known as Steida's plateaux

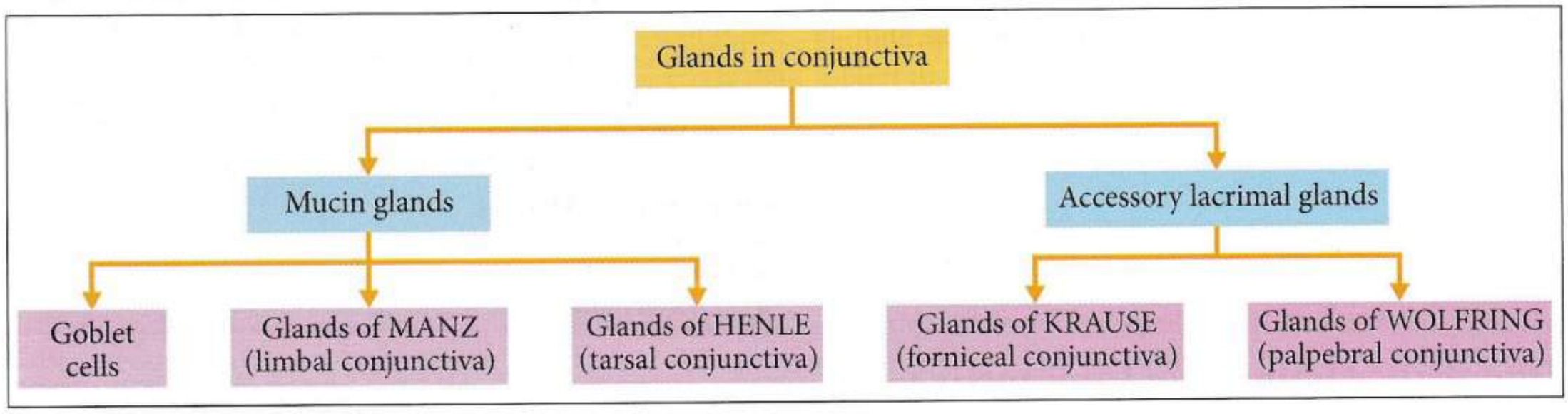
Specialized folds of medial forniceal conjunctiva
- CARUNCLE – contains hair follicles, modified sebaceous and sweat glands
- PLICA SEMILUNARIS – Contains Goblet cells and represents nictitating membrane of animals



Caruncle (1) and Plica Semilunaris (2)

- Looseness of the bulbar conjunctiva makes it ideal for creation of filtering blebs in glaucoma surgery
- Limbal conjunctiva is helpful in holding/fixing the globe during surgery

Glands in Conjunctiva



Histology of Conjunctiva

Conjunctiva has three layers

Epithelium (Outermost Layer)

- This is *non-keratinized*, stratified and squamous
- The morphology of epithelium varies in each part.

Conjunctiva	No. of layers	Cells (Type)
Marginal	5	Superficial – Squamous 3 middle – Polyhedral Deepest – Cylindrical
Tarsal	2	Superficial – Cylindrical Deepest – Cuboidal
Forniceal and (scleral) Bulbar	3	Superficial – Cylindrical Middle – Polyhedral Deepest – Cuboidal
Limbal	10	Superficial – Squamous Middle – Polygonal Deepest/Basal – Cylindrical

Mnemonic

No. of layers in conjunctival epithelium

M	5
T + F and B	5 (2 + 3)
L	10

- **Epithelium contains:**
  - **Goblet cells**[Q] – Secrete gel forming, **MUC5AC,** mucin[Q], which forms the innermost[Q] layer of the tear film. They are located most densely inferonasally in the bulbar and tarsal conjunctiva
  - Melanocytes
  - Langerhans cells

Correlate Box

- Goblet cells are Unicellular
- Parasympathetic stimulation of Goblet cells

↓

Release of (Acetylcholine and VIP) mediators

↓

Goblet cells secrete mucin

Substantia Propria/Stroma

It is divided into two layers

Adenoid/Lymphatic Layer: (Superficial)

- Contains lymphoid tissue
- Develops after 3 months of age, hence, inability of a newborn to produce a follicular reaction
- Contains mast cells

Fibrous Layer: (Deep)

- Contains vessels and nerves
- Contains accessory lacrimal glands of Krause and wolfring

HIGH YIELD

- **Limbal** epithelial basal cells form '**Palisades of vogt** which contain **stem cells**, useful in corneal epithelial regeneration
- These cells do not express corneal epithelial specific markers such as K3, K12, S100A12, instead express ABCG2^{+} and α-enolase as Limbal epithelial stem cell markers.

Other Stem Cell Markers

- CD34
- CD44
- CD133 (Prominin-1)

Lymphatic Drainage of Conjunctiva

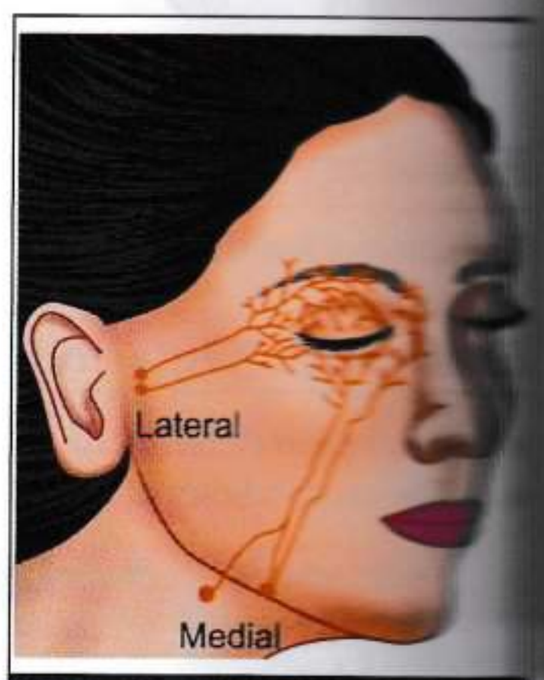
Conjunctiva is the **only structure** in eye which has Lymphatic drainage.

a. Medial part drains into Submandibular lymph nodes
b. Lateral part drains into Preauricular and Superficial Parotid lymph nodes

Mnemonic

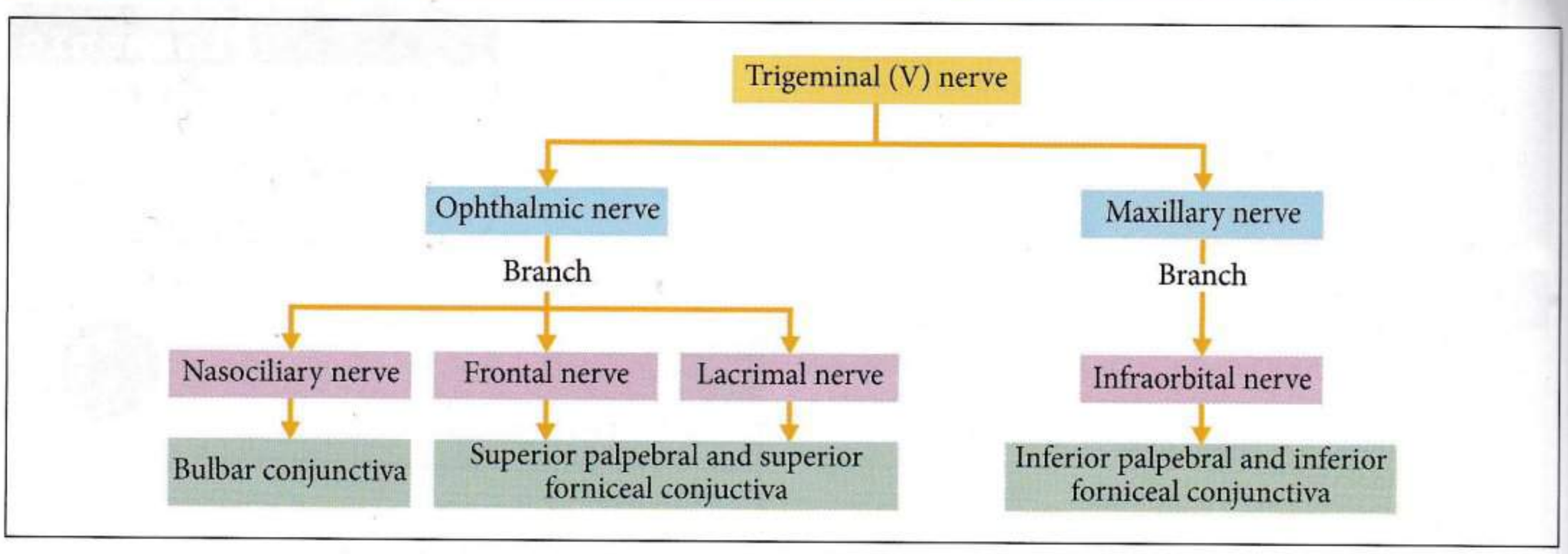
Lymph flows down like TEARS

- Medially, down the cheek and then below mandible
- Laterally, (while lying down on the bed at night) into the ears - auricle



Lymphatic drainage

Nerve Supply of Conjunctiva



HIGH YIELD

Commensals in the Conjunctival Sac

- Coagulase negative staphylococci (CONS) – **Most common** is staphylococcus epidermidis
- *Corynebacterium xerosis*
- Diphtheroids
- *Neisseria catarrhalis*
- Propionibacterium acnes
- *Streptococcus pneumoniae*

CONJUNCTIVITIS

(Commonly known as eye Flu/Red eye/Pink eye)

Conjunctiva forms almost 90% of the ocular surface and is thus, subject to constant exposure by exogenous agents leading to its inflammation.

Clinical Features

Symptoms

Redness, stickiness, Grittiness/Foreign Body sensation, Lacrimation/Tearing, Itching (in allergic causes). Pain and Loss of vision indicate associated corneal involvement.

Signs

EXTRA MILE

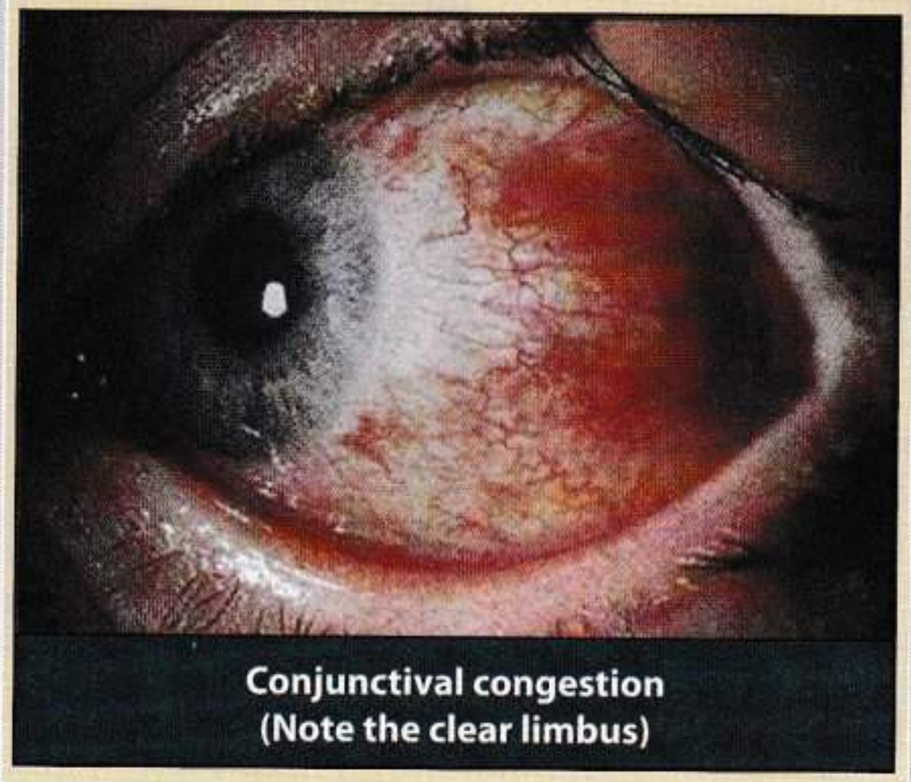
How to examine the conjunctiva?

a. Lower palpebral and forniceal conjunctiva – by drawing the lower lid down and asking patient to look upward
b. Upper palpebral conjunctiva-by Eversion of upper lid using a probe or pencil
c. Upper forniceal conjunctiva-by Double Eversion of upper lid using Desmarre Retractor

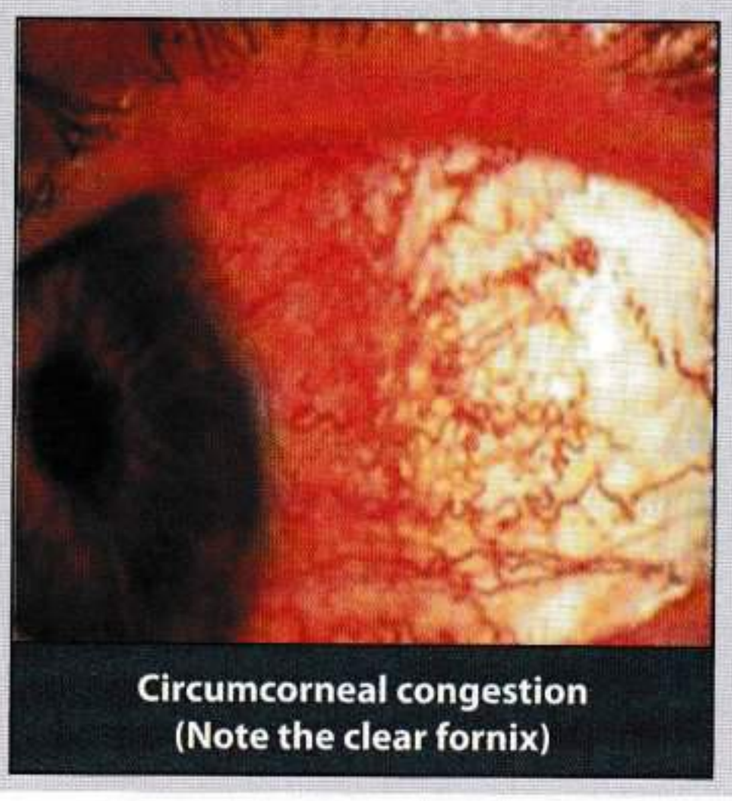
Hyperemia/Injection/Congestion

Two types of congestion are seen

	Conjunctival Congestion	Circumcorneal/Ciliary Congestion
Site	Maximum at FORNIX	Maximum around LIMBUS
Source	Posterior conjunctival artery	Anterior ciliary artery
Color	Bright red	Dull red
Direction of vessels	CENTRIPETAL-on mechanically squeezing, blood refills from Fornix towards Limbus	CENTRIFUGAL-on mechanically squeezing, blood refills from Limbus towards Fornix
Blanching of vessels with Adrenaline	Immediate	No blanching/Delayed
Movement of vessels	Move with conjunctiva	Do not move
Cause(s)	Conjunctivitis	Acute Glaucoma, corneal ulcer/Keratitis, Uveitis



Conjunctival congestion (Note the clear limbus)



Circumcorneal congestion (Note the clear fornix)

Subconjunctival Hemorrhage

It can result from rupture of a conjunctival or an episcleral blood vessel.

Causes:

- Trauma to eye: **Most common cause**[Q] (posterior limit of hemorrhage is visible)
- Orbital Trauma (posterior limit of hemorrhage is not visible – thus, scleral tear suspected)
- Venous congestion
- Blood dyscrasias
- **Hypertension**
- Acute conjunctivitis
- Vicarious menstruation
- Acute febrile systemic illness-like pertussis, meningococcal septicemia, etc.

Chemosis

Edema of the **bulbar conjunctiva**

Causes:

- Acute inflammations: Gonorrheal conjunctivitis, Panophthalmitis
- Orbital outflow obstruction
- Blood abnormalities – Anemia, urticarial, etc.

Chemosis

Discharge

This is a prominent feature of all types/causes of conjunctivitis. It can be watery, mucoid, purulent or mucopurulent

It leads to

- **Stickiness:** cilia get matted together
- **Colored Halos:** occur due to prismatic dispersion of light by discharge, and hence they disappear on washing the eye with water.

Inflammatory Reactions-Morphologic Responses

a) Papillae

These are folds of hypertrophic Epithelium, with a **Central Vascular core** and subepithelial infiltration of lymphocytes and plasma cells. Usually flat topped, but can be dome shaped also.

HIGH YIELD

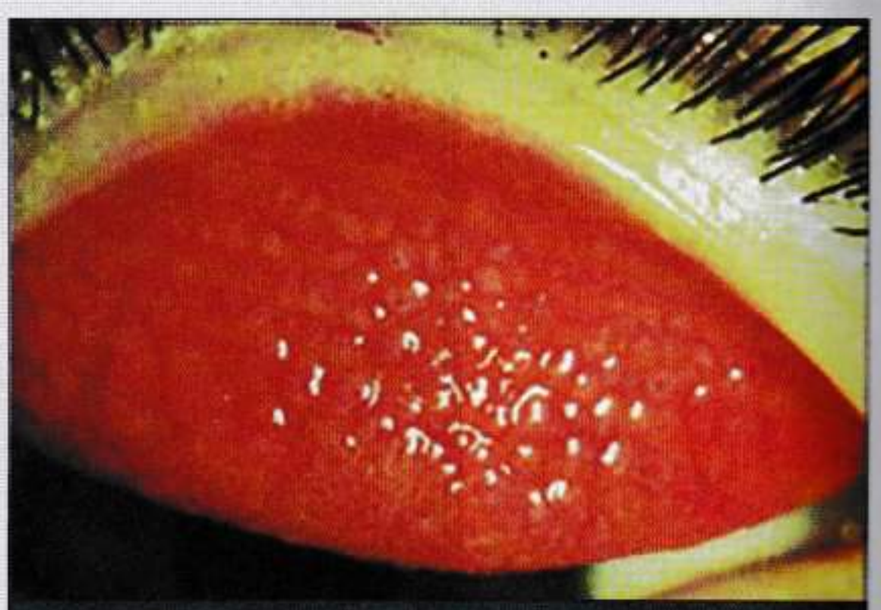
Causes

Acute Papillary Conjunctivitis

- Allergic conjunctivitis[Q]
- Bacterial conjunctivitis

Chronic Papillary Conjunctivitis

- **Contact lens wear**[Q]
- ***Toxic:*** Most commonly involve lower palpebral conjunctiva
- Mucus fishing syndrome: Most commonly involve lower palpebral conjunctiva
- ***Floppy eyelid syndrome:*** Most commonly involve upper palpebral conjunctiva
- Superior Limbic Keratoconjunctivitis: Most commonly involve upper palpebral conjunctiva
- Masquerade syndrome
- **Trachoma**[Q]



Histamine mediated, hyperplasia of vascular system causing elevated red clots

*b) **Follicles**:* are subepithelial **lymphoid aggregates**[Q] – appear as elevated whitish dots

HIGH YIELD

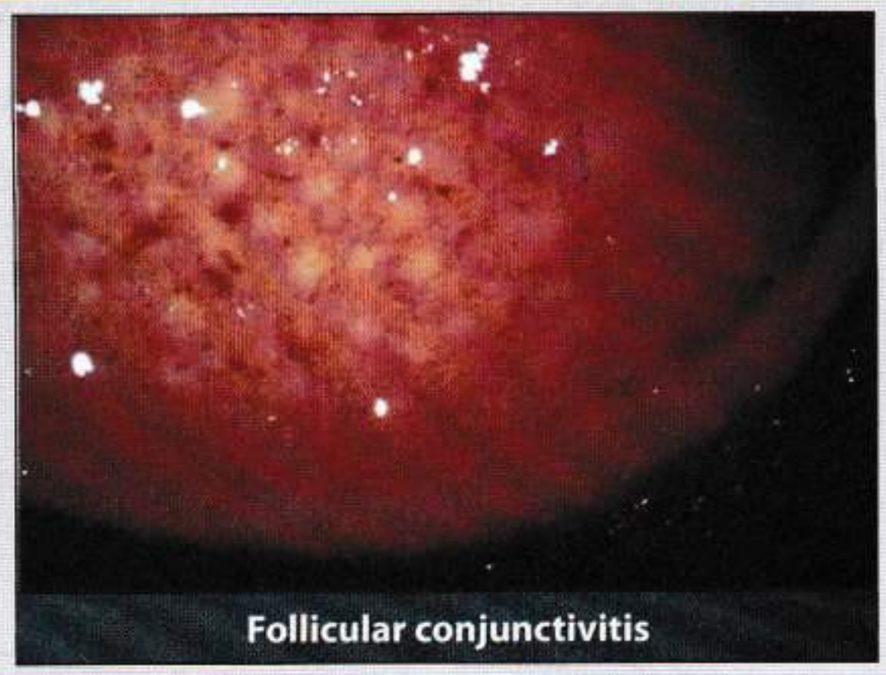
Causes

Acute Follicular

- Viral conjunctivitis (All types of virus)
- Chlamydial conjunctivitis – Adult Inclusion conjunctivitis

Chronic Follicular

- *Chlamydial:* Trachoma and Inclusion Conjunctivitis
- *Viral:* Molluscum contagiosum (only)
- Parinaud oculoglandular syndrome
- Lyme disease
- Moraxella
- Toxic



Follicular conjunctivitis

EXTRA MILE

Topical Drugs causing Toxic Follicular conjunctivitis	Topical Drugs causing Toxic Papillary Conjunctivitis
• Antiviral drugs – Idoxuridine, Trifluorothymidine • Antiglaucoma drugs – Pilocarpine, Brimonidine, Dipevefrin, epinephrine • Cycloplegic – Atropine, Homatropine • Preservatives – Benzalkonium chloride • Neomycin, Gentamycin	• Anesthetic agents – Proparacaine, Tetracaine • Antiviral drugs – idoxuridine

*c) **Membrane formation***

Causes

- Acute—Bacterial/viral
- Chronic—Ligneous conjunctivitis

Adenovirus is the most common cause of Membranous conjunctivitis

*d) **Scarring***

Occurs in response to stromal damage

- Mucous membrane phemphigoid
- Stevens–Johnson syndrome-toxic epidermal necrolysis (Lyell syndrome)
- Atopic (and less commonly vernal) keratoconjunctivitis
- Conjunctival chemical and thermal burns
- Severe bacterial or viral conjunctivitis
- Trachoma
- Drug-induced ('pseudopemphigoid')
- Other: epidermolysis bullosa, pemphigus vulgaris, linear IgA disease, dermatitis herpetiformis, lichen planus, porphyria cutanea tarda, xeroderma pigmentosum, scleroderma, xerophthalmia (vitamin A deficiency)

*e) **Granuloma*** affects stroma

Causes:

- Sarcoidosis
- Parinaud's oculoglandular syndrome

HIGH YIELD

- Based on Type of Discharge and the morphologic response of conjunctiva, conjunctivitis can be

RESPONSE DISCHARGE	PAPILLARY	FOLLICULAR
WATERY	**A** LLERGIC	**V** IRAL
MUCOPURULENT/CATARRHAL	**B** ACTERIAL	**C** HLAMYDIAL

- **MCQ Approach**
  Look for key words
  - Type of discharge
  - Type of morphologic response
  - Chronicity
  - Laterality-usually bilateral (Unilateral Conjunctivitis[Q] suggest – TOXIC, MECHANICAL, PHARMACOLOGICAL, PARINAUD'S oculoglandular syndrome)

BACTERIAL CONJUNCTIVITIS

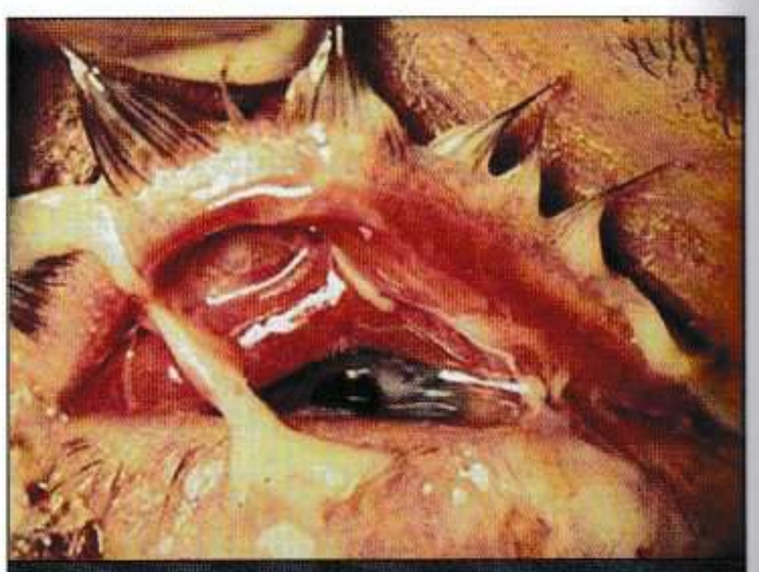
Most cases of bacterial conjunctivitis have a rapid onset unilaterally, and become bilateral in 1–2 days. Various types are:

Acute Mucopurulent Conjunctivitis

- Most common type of bacterial conjunctivitis
- Bilateral, papillary conjunctivitis with mucopurulent discharge
- Most common cause: *Staphylococcus aureus*[Q], *Hemophilus aegypticus* (Koch-weeks bacillus)
- Treatment: Topical Antibiotics

Acute Purulent/Hyperacute[Q] Conjunctivitis/Blenorrhoea[Q]

- Bilateral, papillary conjunctivitis with purulent[Q] discharge
- **Cause:**
  - **Neisseria gonorrhoeae**[Q] – Most common
  - Neisseria meningitidis
- Most common in males, usually the right eye is affected first due to Autoinoculation from genitals—Oculogenital transmission



Hyperacute conjunctivitis

Copious discharge and severe edema

Specific Clinical Features

- Intense pain
- Swollen, overhanging upper eyelid
- Copious[Q] yellow-green colored **purulent discharge**
- Suppurative, tender **Pre-auricular Lymphadenopathy**

HIGH YIELD

Enlarged Pre-Auricular Lymph nodes

- Most commonly in viral conjunctivitis
- Gonococcal conjunctivitis
- Adult Inclusion conjunctivitis

- Iritis
- Corneal complications like marginal ulceration and perforation are the rule and can lead to Blindness

- Most important diagnostic point – Coincidence of urethritis
- Most important prognostic point – Involvement of cornea

Treatment

- Irrigation with warm saline
- I.M. Ceftriaxone 1 g (single dose), followed by oral erythromycin for 2 weeks
- Topical antibiotics: Bacitracin ointment, etc.
- Cycloplegics: if cornea is involved to relieve ciliary spasm

Acute Membranous Conjunctivitis

- **Causes**
  - *Corynebacterium diphtheria* – Most common cause in non-immunized children
  - *Streptococcus hemolyticus* – Most common cause in adults
- Palpebral conjunctiva[Q] is covered with a TRUE membrane, i.e.

A membrane fused with underlying necrotic conjunctival epithelium

↓

It bleeds on Removal

↓

Leaves a raw surface

↓

Leads to formation of symblepharon

EXTRA MILE

SYMBLEPHARON – Adhesion of palpebral and bulbar conjunctiva

- Prevention - by sweeping a glass rod in fornix
- Treatment - by surgical release followed by mucous membrane or amniotic membrane grafting

ANKYLOBLEPHARON – Adhesion of upper and lower eyelid margin

Acute Pseudomembranous Conjunctivitis

- **Cause:**
  - Bacterial-Staphylococci[Q], *Streptococcus pneumoniae*[Q], *Neisseria gonorrhoeae*[Q]
  - Viral
  - Chemical
  - Graft versus Host disease (GVHD)
- Conjunctiva is covered by a pseudomembrane, i.e. coagulated exudate **loosely adherent** to the conjunctival epithelium

↓

DOES NOT bleed on Removal

Angular/Diplobacillary Conjunctivitis

- Cause: Moraxella Lacunata/Axenfeld
  Rarely by, staphylococci
- Source – from the nasal cavity

Specific Clinical Features

- Reddening of the intermarginal strip, at canthi
- Excoriation of skin at canthi (due to maceration of epithelium caused by release of a proteolytic enzyme)
- Frequent blinking
- Blepharitis
- Marginal, shallow, corneal ulcers

Angular conjunctivitis

Treatment

- Tetracycline 1% ointment (2 weeks)
- Zinc[Q] boric eye drops

EXTRA MILE

- Moraxella can cause
  - Angular conjunctivitis
  - Chronic follicular conjunctivitis
- Pneumococcal conjunctivitis: Severe chemosis + petechial hemorrhages (ecchymoses) + pseudomembrane formation
- Staphylococcus aureus: Most common presentation is chronic blepharoconjunctivitis

VIRAL CONJUNCTIVITIS

Usually bilateral, acute follicular[Q] conjunctivitis with watery discharge[Q]
Viral infections usually affect both the conjunctival and corneal epithelium and thus typically cause keratoconjunctivitis[Q]
Various causes are given as follows:

Adenoviral Conjunctivitis

- Most common cause of viral conjunctivitis
- Transmission is by respiratory droplets or fomites

Presentation

Nonspecific Follicular Conjunctivitis

- **Cause:** Adenovirus Type 1-11 and 19
- Most commonly affects lower palpebral conjunctiva

Epidemic Keratoconjunctivitis (EKC)

- **Cause:** Adenovirus Type 8, 19, 37
- Most severe presentation as it can be associated with keratitis (corneal involvement)

↓

Subepithelial infiltrates as a delayed (type iv) hypersensitivity response

↓

Topical steroids indicated for treatment

CIDOFOVIR eye drops may be tried in EKC to prevent formation of corneal opacity

Pharyngo-Conjunctival Fever (PCF)

- Cause: Adenovirus types 3, 4, 7
- Most common presentation, presents with preauricular lymphadenopathy

Acute Hemorrhagic Conjunctivitis/Apollo Conjunctivitis[Q]

HIGH YIELD

Cause

- Picornavirus (RNA virus)[Q]
  - Enterovirus Type 70 [Q]
  - Coxsackie A 24[Q]
- Adenovirus Type 11

Acute hemorrhagic conjunctivtis

Herpes Simplex Conjunctivitis

- Most cases are Unilateral
- Usually occurs in children <5 years of age

Molluscum Contagiosum

- **Unilateral, Chronic** follicular conjunctivitis
- Most common in children 2–4 years of age
- **Presentation:**

Lesion is a painless, pale, Umblicated nodule on the lid margin

↓

Secretes virus

↓

Causes conjunctivitis as a toxic response to viral particles

Molluscum conjunctivitis

CHLAMYDIAL CONJUNCTIVITIS

Correlate Box

Chlamydiae exists in 2 forms
- Infective (E)xtracellular—(E)lementary body
- (R)eplicating Intracellular—(R)eticular body

Source of ocular infection
- In males - Urethritis and epididymitis
- In females - Cervicitis and PID

Chlamydia trachomatis
- A, B, Ba, C Serovars[Q] → Trachoma
- D - K Serovars[Q] → Adult inclusion conjunctivitis; Ophthalmia neonatorum

Adult Inclusion Conjunctivitis/Swimming Pool Conjunctivitis[Q]

Acute or chronic follicular conjunctivitis with mucopurulent discharge

- **Cause:** Chlamydia Trachomatis D-K serovars[Q]
- **Transmission:**
  90% cases – autoinoculation from genitals
  10% cases – eye to eye spread by water in swimming pools
- **Specific clinical features**
  - Benign[Q], self-limited course
  - Follicles – Most commonly seen in Lower fornix[Q]
  - Preauricular Lymphadenopathy
  - Micropannus
- **Diagnosis:**
  - Direct immunofluorescence
  - Mc Coy cell culture
  - Giemsa staining shows intracytoplasmic[Q] inclusion bodies known as HP (Halberstaedter-Prowazek bodies)

- **Treatment:**
  - Azithromycin 1 g oral single dose (both the patient and the sexual partner)
  - Doxycycline 100 mg BD for 7 days

Trachoma/Egyptian Ophthalmia[Q]

Bilateral, chronic, Follicular conjunctivitis with mucopurulent discharge

- **Cause:** Chlamydia trachomatis **A, B, Ba, C serotypes**
- **Transmission:** Transfer of conjunctival secretions by

Ⓕ Finger Ⓕ Fly (musca sorbens) (both these come in line with finger) Ⓕ Fomite

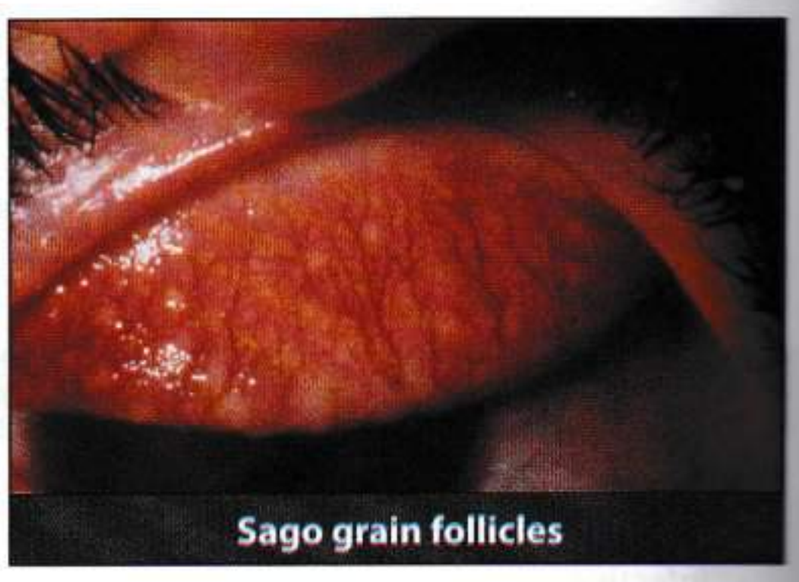
- Most commonly seen in pre-school children (1–9 years)

Specific Clinical Features

- Initial episode – Innocuous
- Repeated episodes associated with (2°) secondary bacterial infection (Most commonly by *Hemophilus aegyptius*) incite type IV[Q] hypersensitivity reaction and causes—

Active Stage

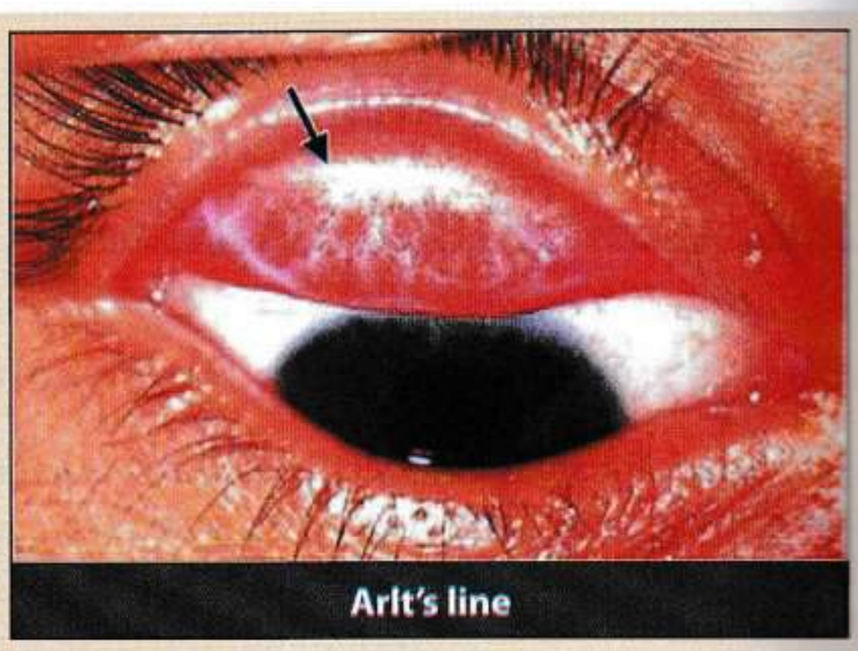
- **Mixed (papillary[Q] and follicular[Q])** conjunctivitis
- **Sago grain follicles[q]**
  - Appear 1st in lower fornix, but most commonly seen in the upper palpebral (Tarsal) Conjunctiva[Q]
  - Differentiated from other causes of follicles by
    - Presence of Leber cells
    - Necrosis within follicles
    - Resolution with cicatrization


Sago grain follicles

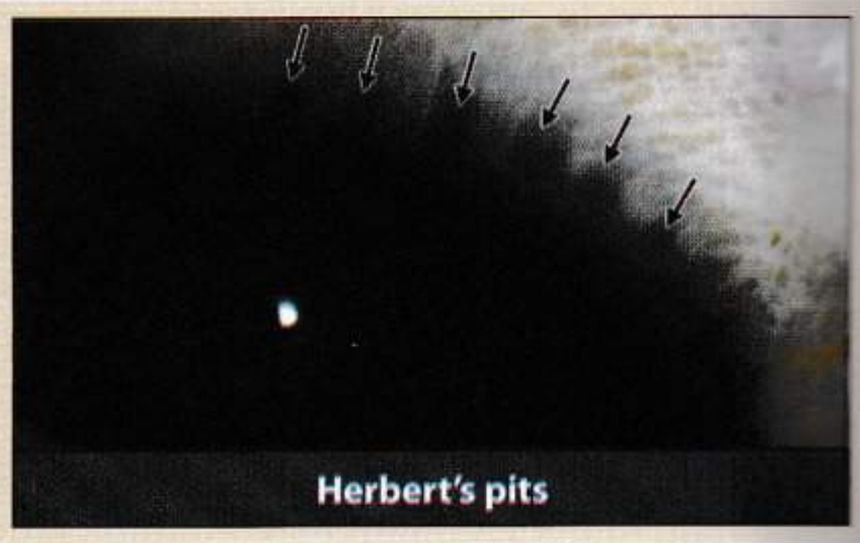
Cicatricial Stage

Both active and cicatricial signs are simultaneously present.

ARLT'S line[Q] – linear/stellate scar, seen at the junction of anterior (upper) 1/3rd and posterior (lower) 2/3rd of the upper tarsal conjunctiva

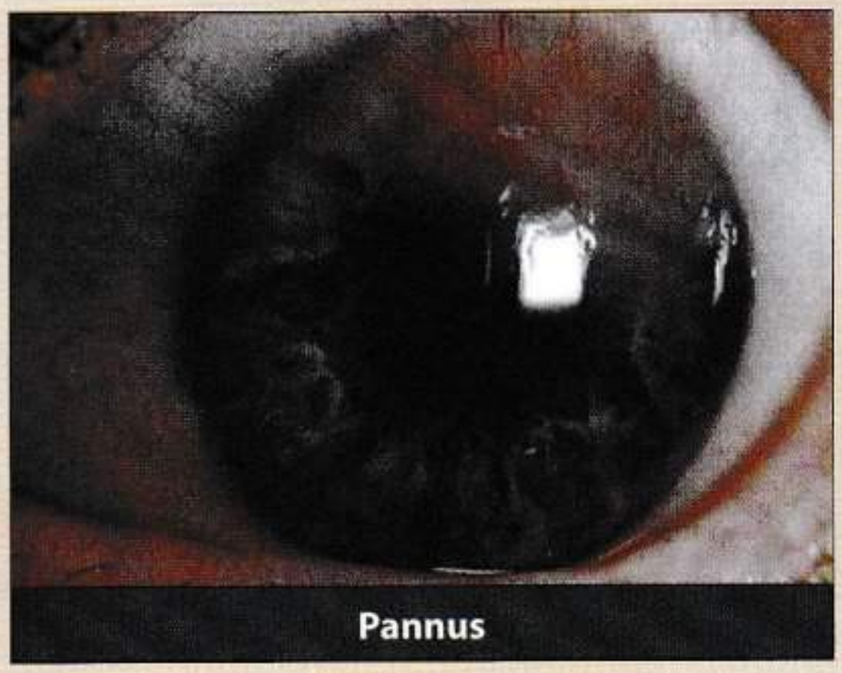

Arlt's line

HERBERT's Pits[Q] – Shallow depressions seen after cicatrization of limbal follicles


Herbert's pits

BULBAR follicles are pathognomonic for TRACHOMA [Q]

PANNUS[Q] – Lymphoid infiltration with vascularization of the superior cornea



Pannus

Sequelae

- Corneal opacity[Q]
- Due to scarring and cicatrization of the eyelids
  - Trichiasis
  - Entropion[Q]
  - Tylosis
  - Distichiasis
- Dry eye/Xerosis[Q]

All the above sequelae have disastrous effects on the cornea leading to the

ONLY COMPLICATION – Corneal Ulcer[Q] → Corneal Scarring → Visual impairment

Treatment

It is indicated as follows

- If active trachoma prevalence > 10% in children aged 1 to 9 years – Mass prophylaxis
- If between 5 and 10%: Treatment for affected, children and their families
- If below (<5%) – only facial cleanliness and environmental hygiene

(SAFE strategy by WHO-1996)[Q]

Surgery for Trichiasis—Bilamellar resection

Antibiotics—Tetracycline 1% eye ointment for 6 weeks or **oral Azithromycin** (DOC) 20 mg/kg up to 1 g yearly

Facial cleanliness

Environmental hygiene

Classification – WHO (FISTO)

Trachomatous Inflammation - Follicular (TF)	>5 follicles in upper tarsal conjunctiva, ≥0.5 mm[Q]	Active disease - topical Antibiotics
Trachomatous Inflammation Intense (TI)	Pronounced inflammatory thickening of tarsal conjunctiva that obscures > 50% of normal deep vessels	Active disease - systemic Antibiotics
Trachomatous scarring (TS)	White lines/bands	Inactive
TrachomatousTrichiasis (TT)	At least one eyelash rubs on eyeball	Surgery
Corneal opacity (CO)	Pupil margin blurred when viewed under opacity	Visual loss

Mnemonic

Trachoma – SAFE 4 CHAPS

- **SAFE** strategy for treatment
- **4** – Type IV Hypersensitivity
- **C** – Corneal ulcer-only complication
- **H** – Herbert pits
- **A** – Arlt's line
- **P** – Pannus
- **S** – Sago grain follicles

Extra Mile

WHO-GET 2020

WHO alliance for Global **Elimination** of Trachoma by 2020

Ophthalmia Neonatorum

- Conjunctivitis occurring within the first 4 weeks of life, due to transfer of infection from mother to child during delivery
- It is diagnosed by discharge from the eyes of a neonate
- It can be due to various causes, depending upon the time of presentation

Ophthalmia neonatorum

Onset (hours after birth)	Cause	Treatment
Within first 6 hours	CHEMICAL (Silver nitrate) conjunctivitis	Wash eye Erythromycin ointment
24–48 hours (most severe)[Q]	Neisseria gonorrhoeae	Intramuscular Ceftriaxone
2–5 days	Other Bacteria (Gram positive more common than Gram-negative)	Topical Antibiotics
5–7 days	HSV-II	Acyclovir 3% ointment and I.V. Acyclovir
> 1 week (most common)[Q]	Chlamydia Trachomatis (D-K)	

Prophylaxis

- **Crede's** method – Topical 1% silver nitrate solution (as it is also a cause, newer methods have been adopted)
- 0.5% erythromycin
- 1% Tetracycline

  ] Preferred method, usually as a Single application within 1 hour after birth
- Povidone-Iodine 2.5% has also shown equal efficacy

ALLERGIC CONJUNCTIVITIS

- Usually bilateral, papillary conjunctivitis with watery discharge and **'ITCHING'**
- It is a Type I and Type IV (some forms) hypersensitivity reaction
- It can be either
  - Seasonal – Occurs most commonly in spring-summer due to OUTDOOR allergens such as pollen
  - Perennial – Occurs throughout the year, worse in Autumn, due to INDOOR allergens such as house dust mite
- Various types are discussed below:

Vernal Keratoconjunctivitis/Spring Catarrh/Warm Weather Conjunctivitis

- Recurrent, Bilateral, chronic with exacerbations and characteristic white, **ropy** discharge[Q] with Intense itching[Q]
- Type I (IgE mediated)[Q] and Type II hypersensitivity response to exogenous allergens such as pollen
- Onset is more common in boys around 5 years[Q] of age, but resolves by early teens
- Exacerbations are more common in **summers**[Q]
- Family history of atopy is present.

Specific Clinical Features

VKC can be divided into the following.

Palpebral Form (Most common[Q] presentation)

- Papillary hypertropy[Q]

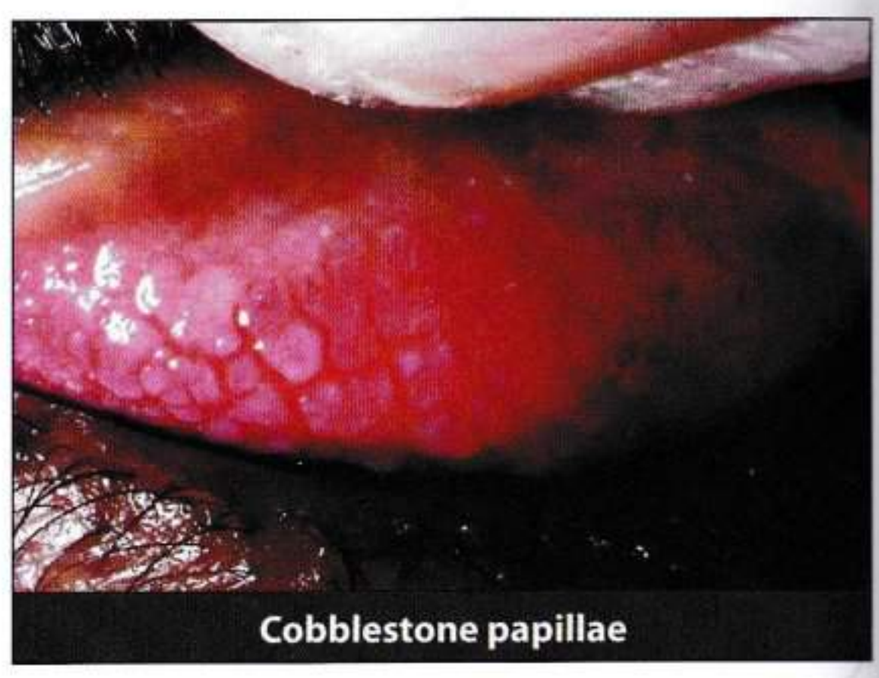
↓

Polygonal, flat[Q] topped, giant papillae (>1 mm), appearing as

↓

Cobblestone/Pavement stone papillae

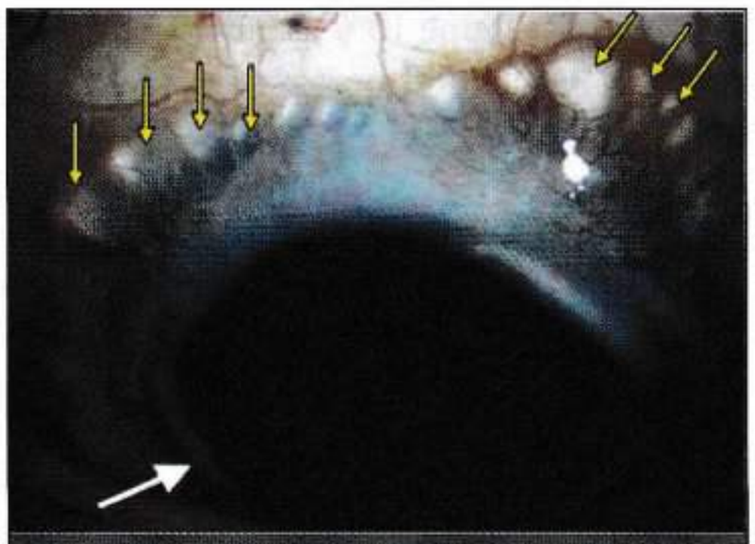
- Mucous plaques are seen between papillae



Cobblestone papillae

Limbal Form

- Gelatinous limbal papillae
- **Horner trantas dots**[Q] – Collections of eosinophils and epithelia debris at the LIMBUS[Q] appearing as white dots.
- **Pseudogerontoxon/cupid's bow**
  - Seen in recurrent VKC
  - A paralimbal gray white band of lipid deposition due to repeated stromal infiltration (It resembles Arcus senilis)



Horner Trantas spots (yellow arrows) and pseudogerontoxon (bold white arrow)

Keratopathy

Punctate (dot like) epithelial keratitis
↓
Coalescence leads to epithelial erosion/defects
↓
Plaque containing mucous and fibrin covers defect
↓
Epithelial healing impaired
↓
Formation of shield ulcer[q] (Togby's ulcer)
↓
Heals with subepithelial scar formation
↓
Visual impairment

Shield ulcer

Other Signs

- **Dennie-Morgan line** – An extra lower lid crease
- **Maxwell-Lyon Sign** – Pseudomembrane formation due to ropy discharge, when the upper eyelid is everted and exposed to heat
- Keratoconus is more common
- Herpes simplex keratitis is more common

Mnemonic

Features of VKC – PORSCHE

PO – Pseudogerontoxon
R – Ropy, stringy discharge
S – Shield ulcer
C – Cobblestone papillae
H – Horner trantas dots
E – IgE (Type 1 hypersensitivity reaction)

Treatment

- Cool compresses
- Topical Antihistamines
- Topical Mast cell stabilizers – Sodium cromoglycate[Q], Nedocromil, Lodoxamide, Pemirolast
- **Topical dual action drugs** – Azelastine 0.05%, Ketotifen, **olopatadine 2%**[Q], Bepelastine, Alcaftadine – These are the drugs of choice.
- Oral Antihistamines – Only in severe cases as they may also decrease tear production
- **Topical steroids** – Usually added as INITIAL therapy in acute exacerbations

↓

Taper after episode subsides

- Acetylcysteine 10% or 20% – a mucolytic agent
- Antibiotics and steroids for shield ulcer

Atopic Keratoconjunctivitis (AKC)

- Non-remitting, chronic, bilateral papillary conjunctivitis
- Onset is the 2nd to 5th decade, with low expectation of resolution
- Tends to be perennial

Specific Clinical Features

Eyelid

- **Hertoghe sign** – absence of lateral portion of eyebrow
- Periocular skin develops fissuring, scaling etc
- Cicatricial entropion, madarosis, blepharitis are commonly associated

Conjunctiva

- Papillary hypertrophy
- Subepithelial fibrosis leading to cicatricial changes

Keratopathy

Most commonly seen in punctate epithelial keratitis with neovascularization and scarring

Difference between	VKC	AKC
Age	Children	Adults
Sex	Males > Females	Males = Females
Resolution	At puberty	Chronic
Conjunctiva affected[Q]	Upper palpebral	Lower palpebral
Cicatrization	Rare	Common
Papillae	Giant (> 1 mm)	Smaller (0.3–1 mm)
Corneal signs	Shield ulcer	Persistent epithelial defects
Eyelid Involvement[Q]	Absent	Always present

Giant Papillary Conjunctivitis (GPC)

- **Mechanically induced**[Q]
- Type I and **Type IV**[Q] hypersensitivity mediated
- **Cause:**
  - **Most common: Contact lens wear**[Q] (Soft lens > Rigid lens), due to lens edge causing irritation or due to buildup of proteinaceous deposits on surface
  - Protruding suture ends[Q]
  - Scleral buckle
  - Ocular **prostheses**[Q] (artificial eyes)
  - Filtering blebs
- Most commonly affects the upper palpebral (tarsal) conjunctiva

Phlyctenular Keratoconjunctivitis

- Unilateral, chronic nodular keratoconjunctivitis
- **Type IV**[Q] hypersensitivity mediated response to **endogenous**[Q] allergens

Cause[Q]

- Hypersensitivity to Tuberculoprotein (in countries where TB is still prevalent)
- Staphylococcal proteins (in developed countries where prevalence of Mycobacterial diseases have declined)

Clinical Features

Conjunctiva

- Mucopurulent discharge
- Phlycten

Subepithelial inflammatory nodules, raised above surface, most common on bulbar conjunctiva near the limbus

↓

Necrosis of nodules and ulceration

↓

Re-epithelialization with no scarring

Cornea

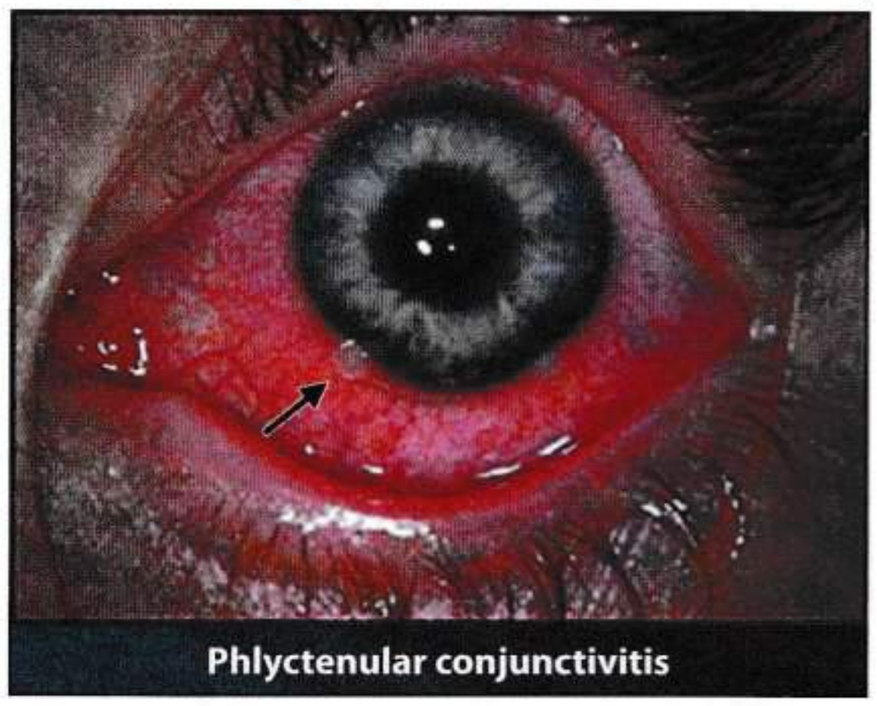
Phlycten has a limbus to center spread

↓

Ulceratis

↓

Scarofulous ulcer | Fasicular ulcer[Q] | Miliary ulcer



Phlyctenular conjunctivitis

Treatment

- Topical steroids are Drug of Choice[Q]
- Topical antibiotics and cycloplegics – in case of corneal involvement

MISCELLANEOUS CONJUNCTIVITIS

Ocular Cicatricial Pemphigoid

- Bilateral, chronic progressive cicatrizing conjunctivitis
- Most common occurs in patients aged > 50 years, F > M

Correlate Box

Cicatricial pemphigoid or mucous membrane pemphigoid is a group of putative autoimmune inflammatory, subepithelial blistering mucocutaneous diseases, characterized by linear antibody (IgG or IgA) and complement deposition at epithelial basement membrane, affecting the oral cavity, nasopharynx, upper airways, GIT and conjunctiva

Genetic susceptibility Trigger agent

↓

Type II Hypersensitivity response

↓

Autoantibodies bind to autoantigens at the epithelial basement membrane zone

↓

vation of complement and recruitment of inflammatory cells (predominantly T lymphoc

↓

Leads to

↓

Fibroblast activation

↓

Subepithelial fibrosis

↓

Scarring

Localized separation of the epidermis from dermis due to loss of hemidesmosomal attachm

Ocular Clinical Features

Foster's Staging

Stage 1 : Subconjunctival scarring and fibrosis
Stage 2 : Forniceal foreshortening
Stage 3 : Symblepharon
Stage 4 : Ankyloblepharon

Stevens-Johnson Syndrome

- Bilateral, Acute, Nonprogressive cicatricial conjunctivitis
- Most common in young adults, M > F
- **Cause:** Type IV hypersensitivity reaction to Drugs (sulfonamides, NSAIDS) or systemic infection (Mycoplasma pneumoniae, HSV)
- **Ocular Clinical Features:** develop 2 weeks after symptoms of malaise, fever, headache
  - Hemorrhagic crusting of eyelids
  - Pseudomembrane formation with papillary hypertrophy
  - Keratinization of conjunctiva and lid margin
  - Dry eyes and meibomian gland disease
- Mucosal involvement of mouth is most commonly associated

Trans-retinoic acid 0.01% or 0.025% can be used to reverse keratinization of ocular surface

Ligneous Conjunctivitis

- Bilateral, chronic (with recurrence and remission pseudomembranous[Q] conjunctivitis)
- Most common occurs in young children, F > M
- **Cause:** Mutation in Type 1 plasminogen gene causing impaired plasmin mediated fibrin degeneration

- **Clinical Features:**

Red white lobular masses on upper palpebral (tarsal) conjunctiva

↓

Formation of pseudomembrane

↓

WOODY membrane, adherent to underlying conjunctiva

Ligneous conjunctivitis

- **Treatment**
  Surgical removal with Diathermy → followed by postoperative topical heparin, steroid and acetyl cysteine.

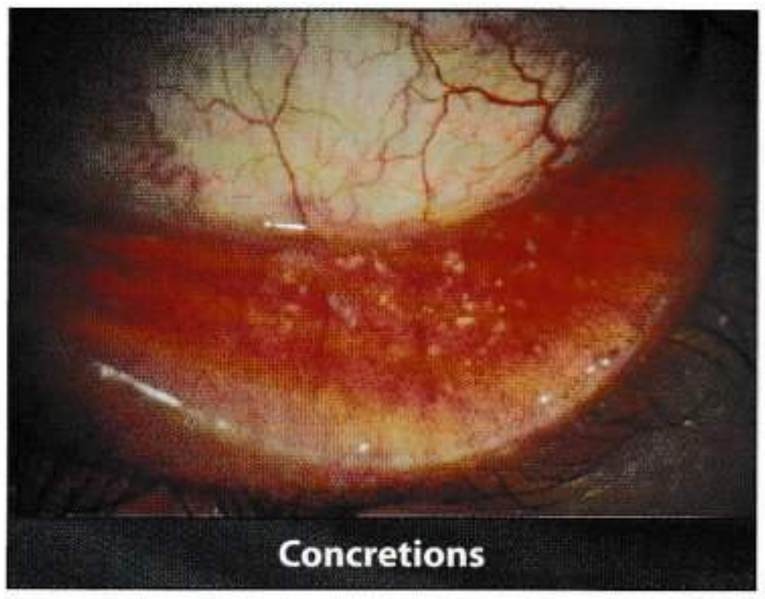
Parinaud Oculoglandular Syndrome

- Unilateral, Granulomatous follicular conjunctivitis with regional lymphadenopathy
- Most common causative association with bartonella henselae (cat-scratch disease)
- Can also be associated with OPHTHALMIA NODOSA (due to caterpillar hair)[Q]

CONJUNCTIVAL DEGENERATIONS

Concretions

- Accumulation of epithelial cells and inspissated mucus in depressions of Henle glands
- Appear as minute, yellow, hard spots in palpebral conjunctiva
- No calcification

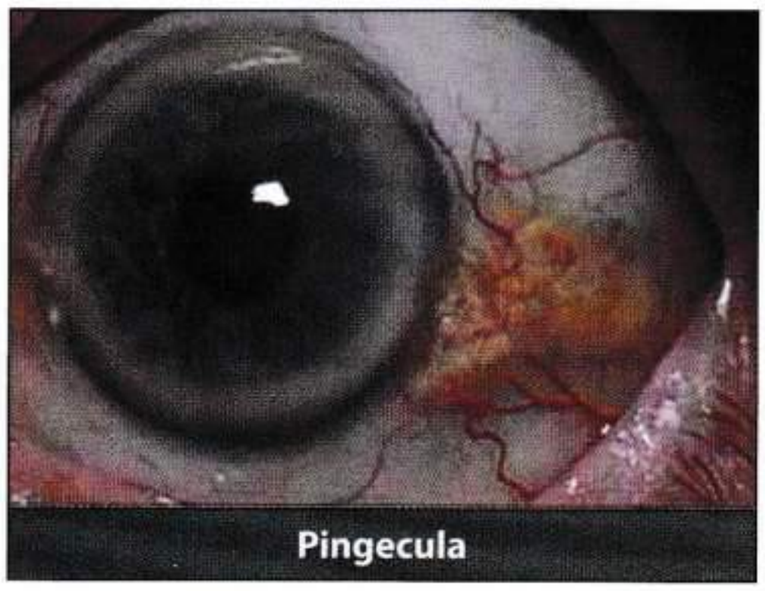


Concretions

Pinguecula

- Bilateral, elastotic degeneration[Q] of the collagen fibrils of conjunctival stroma
- Presents as elevated, yellow-white ('fat'-like) mounds most commonly on the Nasal Bulbar conjunctiva near the LIMBUS[Q]

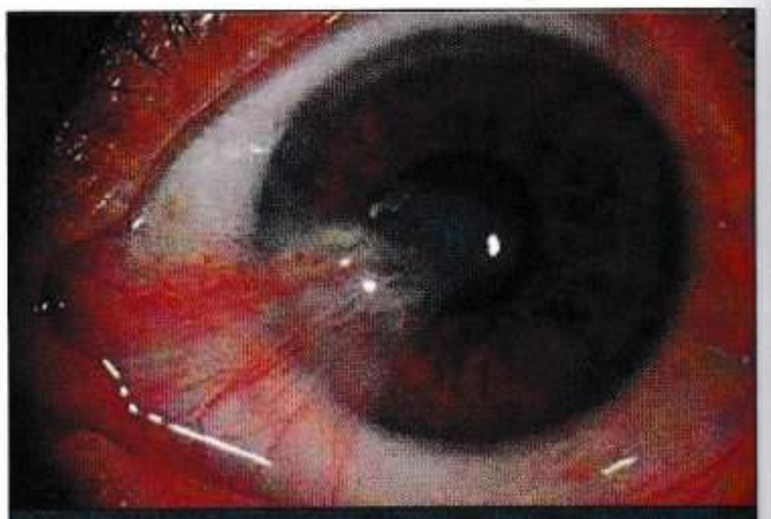
Pinguecula are associated with an increased risk of ARMD



Pingecula

Pterygium

- A triangular, fibrovascular growth of degenerative subconjunctival tissue over the cornea[Q], destroying its Bowman's[Q] membrane and superficial stroma
- Histologically, similar to Pinguecula showing elastotic degeneration of the subconjunctival tissue with added vascularization
- Most commonly seen nasally situated always within the palpebral aperture[Q], though it can be present temporally-also known as double pterygium



Pterygium

Cause

- Associated with UV[Q] light exposure

Recent Advances

Limbal stem cell deficiency disorder causing activation of MMPs

Clinical Features

- Apex points toward cornea
- **Islets of vogt and stockers line** (iron deposition) are seen anterior to the Head of pteryguim
- Usually asymptomatic
- May present with
  - Visual disturbances if it encroaches upon the visual axis (> 4 mm)
  - Corneal astigmatism[Q] – with the rule
  - Cosmetic intolerance

Treatment

Surgical excision (Bare Sclera Technique)

↓

High rate (30–80%) of recurrence

↓

To reduce recurrence

↓

- β-irradiation
- Topical mitomycin C
- Autografting
  - ↓ Autograft usually harvested from the superior paralimbal area
    - ↓ Sutures
    - ↓ Fibrin glue
    - ↓ Autologous Serum

Difference between:

PSEUDO-PTERYGIUM	PTERYGIUM
• Postinflammatory • Probe can be passed under it, as neck is free from Limbus • Involves palpebral aperture and fornix	• Noninflammatory • Probe cannot be passed under it, as neck adherent to Limbus • Involves only palpebral aperture

PERFECT Surgery – Pterygium extended resection followed by extended conjunctival transplantation

HIGH YIELD

Hypersensitivity reactions in Conjunctivitis

Type I and II	Vernal Keratoconjunctivits (VKC)[Q]
Type I and IV	Giant papillary conjunctivitis (GPC)[Q]
Type II	Ocular cicatricial pemphigoid (OCP)
Type IV	Chemical/Toxic conjunctivitis[Q] Phlyctenular keratoconjunctivitis (PKC)[Q] Trachoma Epidemic keratoconjunctivitis (EKC) Stevens Johnson syndrome

LAST MINUTE REVISION – ONE LINERS

- Conjunctival epithelium is nonkeratinized stratified squamous.
- Glands of Krause and wolfring (accessory lacrimal glands) are responsible for Basal tear secretion.
- Palpebral conjunctiva is firmly adherent whereas bulbar conjunctiva is freely movable.
- GOBLET cells are present in conjunctival epithelium, secrete mucin which forms innermost layer of tear film.
- Limbal epithelial stem cell marker is ABCG 2.
- Conjunctiva is the only structure which has Lymphatic Drainage.
- CONS are the most common commensals.
- *Staphylococcus aureus* is the most common cause of bacterial conjunctivitis.
- *Neisseria gonorrhoeae* causes Hyperacute conjunctivitis with copious discharge in adults and ophthalmic neonatorum in children within 48 hours after birth.
- Viral (Adenovirus) is the most common cause of membranous conjunctivitis.
- True membrane bleeds on removal
- Moraxella lacunata/axenfeld causes Angular conjunctivitis and can be treated with zinc and tetracycline.
- Apollo conjunctivitis is acute hemorrhagic and is most commonly caused by enterovirus type 70 and coxsackie A 24 (Picornaviruses).
- Molluscum contagiosum produces a nodule with central umblication.
- Swimming pool conjunctivitis is caused by Chlamydia.
- Trachoma is the most common cause of preventable blindness in the world.
- Corneal ulcer is the only complication of Trachoma.
- Trachoma causes both papillary hypertrophy and follicular hyperplasia.
- SAFE is the WHO strategy for control of Trachoma.
- Bulbar follicles are pathognomonic for Trachoma.
- Arlt's line, Herbert's pits and pannus are seen in Trachoma.
- VKC is characterized by STRING, ROPY discharge, cobblestone papillae, Horner Trantas dots, shield ulcer and pseudogerontoxon.
- GPC is most commonly due to CL wear.
- Pinguecula and Pterygium both are associated with exposure to UV rays and show elastotic degeneration.
- Pterygium is a Limbal stem cell deficiency disorder.
- Argyrosis is deep staining of conjunctiva due to use of silver salts.
- Conjunctivochalasis are folds of redundant conjunctiva heaped at lid margin in old age.
- Blanket therapy for trachoma is given in endemic areas-1% tetracycline ointment (BD) 4–5 days in a month for 6 months.
- Cysticercosis can cause a conjunctival cyst.
- Membranous and Pseudomembranous conjunctivitis cannot be clinically distinguished.
- Phenylephrine test is used to differentiate between conjunctival, episcleral and scleral congestion, as 2.5% phenylephrine branches episcleral and conjunctival vessels, but not scleral vessels.

IMAGE-BASED QUESTIONS

There are multiple probable questions that can be asked on a single image.
Question numbers 1 and 2 are based on Image 1.

Image 1

1. **Identify the ocular instrument**
   a. Desmarres lid retractor b. Ptosis forceps
   c. Jaffe lid speculum d. Lacrimal sac blunt dissector
2. **The ocular instrument can be used for**
   a. Eversion of lower eyelid
   b. Eversion of upper eyelid
   c. Hooking extraocular muscle
   d. Periotomy

Question numbers 3 to 6 are based on Image 2.

Image 2

3. **Identify the ocular pathology.**
   a. Trichiasis
   b. Fungal corneal ulcer
   c. Trachoma
   d. Cicatricial entropion
4. **The parents of a 6-year-old child notice that she has decreased vision. Examination of the eye shows the above corneal picture. Microscopic examination of a conjunctival scrapings shows lymphocytes, plasma cells, neutrophils, and scattered corneal epithelial cells that have cytoplasmic inclusion bodies. What infectious agent is most likely to produce these findings?**
   a. Neisseria gonorrhoea
   b. Staphylococcus aureus
   c. Herpes simplex virus
   d. Chlamydia trachomatis
5. **What is the best treatment for the above patient?**
   a. Tetracycline eye ointment
   b. Epilation of eyelashes
   c. Topical Azithromycin
   d. Oral Azithromycin
6. **The patient is suffering from which stage of trachoma?**
   a. Trachomatous inflammation intense
   b. Trachomatous scarring
   c. Trachomatous corneal opacity
   d. Trachomatous trichiasis

Question number 7 is based on Image 3.

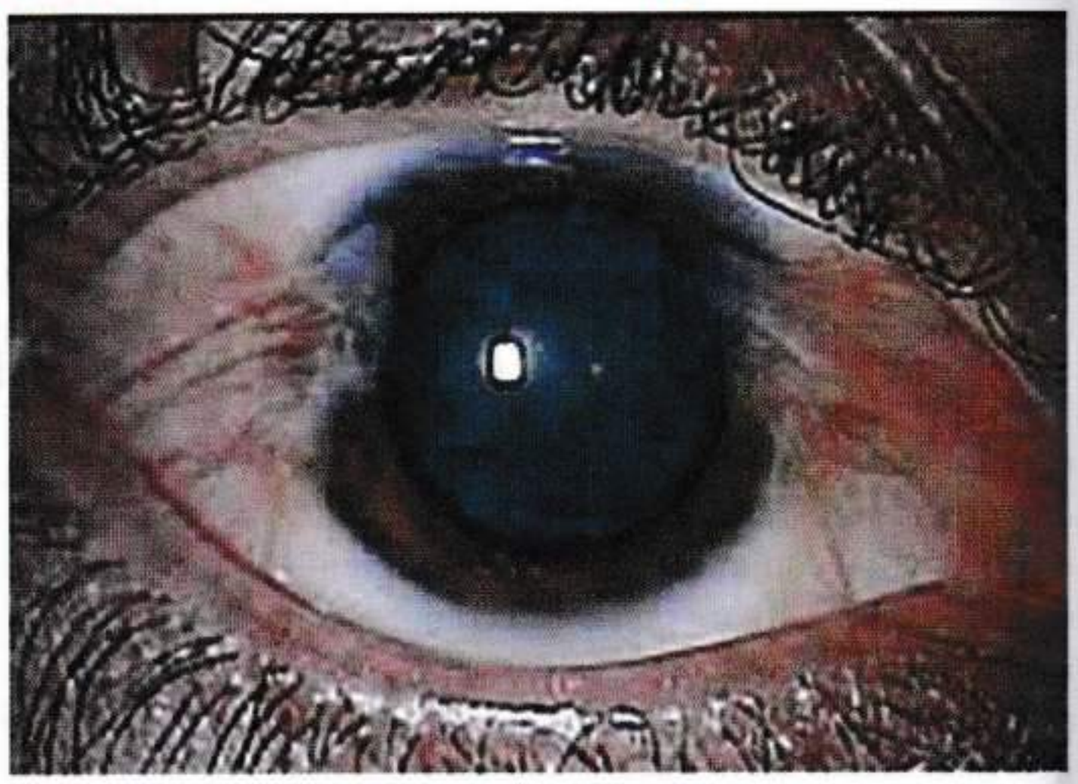


Image 3

7. **Identify the ocular pathology.**
   a. Nodular episcleritis b. Pinguecula
   c. Bitot's spots d. Double pterygium

Question numbers 8 and 9 are based on Image 4.

Image 4

8. **Identify the ocular pathology.**
   a. Arlt's line
   b. Acute membranous conjunctivitis
   c. Follicular hyperplasia
   d. Angular conjunctivitis
9. **The above pathology is associated with**
   a. Chlamydia trachomatis
   b. Neisseria gonorrhoea
   c. Corynebacterium diphtheria
   d. Moraxella axenfeld

Most Recent Image-based Questions of 2019-2017 are given at the end

Most Recent Image-Based Questions of 2019-2017

Question number 10 is based on Image 5.

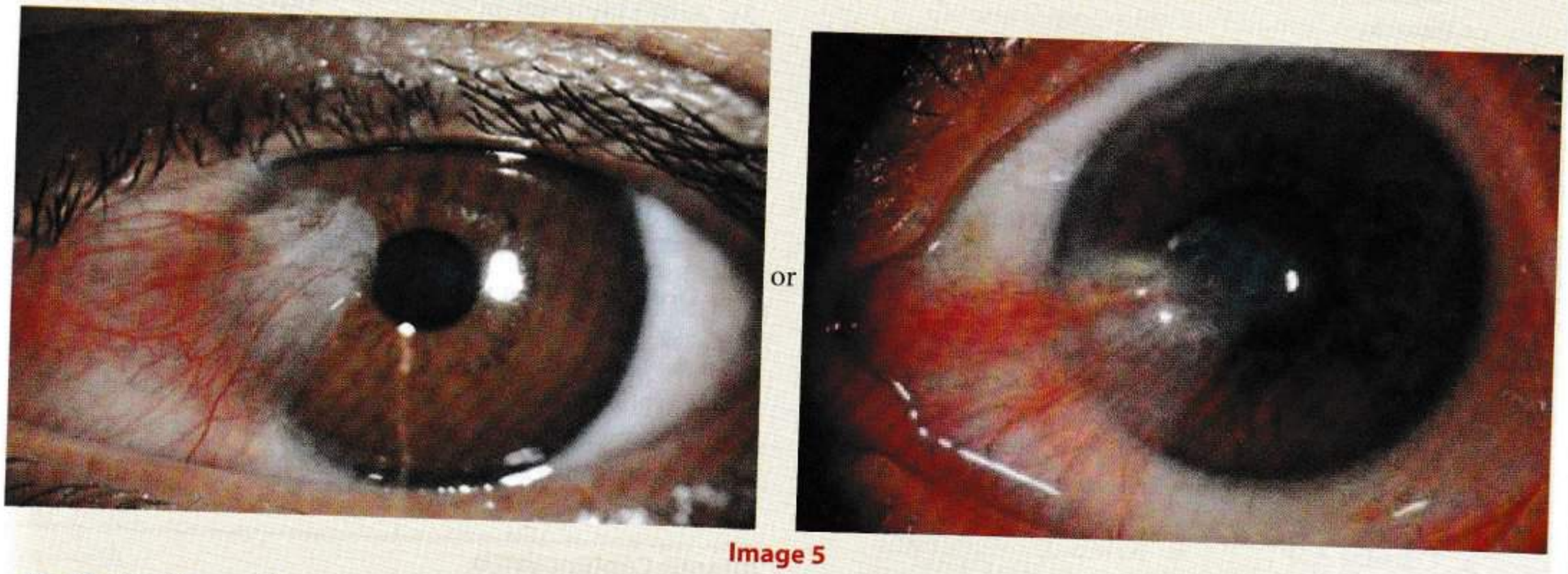


Image 5

10. Identify the condition shown in the given images *(AIIMS Nov 2017)*

a. Pinguecula
b. Pterygium
c. Ocular dermoid
d. Ocular surface squamous neoplasia

11. The condition seen below would cause maximum visual disturbance due to *(Recent question Jan 2019)*

a. Cataract
b. Astigmatism
c. Visual axis enchroachment
d. Glaucoma

MULTIPLE CHOICE QUESTIONS

Anatomy

12. Universal marker of limbal epithelial stem cells: *(AIIMS May 2015)*

a. Elastin
b. Keratin
c. Collagen
d. ABCG2

13. Which organism is considered as normal flora of conjunctiva?

a. B. Proteus
b. Pseudomonas
c. E coli
d. Corynebacterium xerosis

14. Normal flora of the eye constitutes?

a. E. coli
b. B. proteus
c. C.gonococci
d. Diptheroids

15. Conjunctival epithelium is – *(Recent pattern Nov/Dec 2016)*

a. Pseudostratified
b. Stratified columnar
c. Stratified non keratinized squamous
d. Transitional

16. Lymphatic drainage is present in which of the following ocular structures

a. Choroid
b. Iris
c. Sclera
d. Conjunctiva

Bacterial Conjunctivitis

17. Which of the following is false regarding acute conjunctivitis? *(AIIMS May 2013)*

a. Pupil is not affected
b. Vision is not affected
c. Topical antibiotic is the treatment of choice
d. Cornea is infiltrated

18. Angular conjunctivitis is caused by *(Recent pattern Nov/Dec 2016)*

a. Neisseria
b. Moraxella
c. Streptococcus
d. Corynebacterium

19. Which of the following organism causing acute bacterial conjunctivitis is NOT associated with a polymorphonuclear response? *(Recent pattern 2013-14)*

a. Moraxella lacunata
b. Staphylococcus aureus
c. Haemophilus influenza
d. Streptococcus Pneumoniae

20. Most common conjunctivitis in newborn *(Recent pattern July 2016)*

a. Gonococcal
b. Staphylococcal
c. Streptococcal
d. Pneumococcal

Most Recent Image-based Questions of 2019-2017 are given at the end

21. Subconjunctival hemorrhage occurs in all conditions except–
a. Passive venous Congestion *(Recent pattern Dec 2015)*
b. Pertussis
c. Trauma
d. High intraocular tension

22. All are true about membranous conjunctivitis except
a. Easy to peel
b. Caused by Corynebacterium
c. May lead to cicatrization
d. May cause corneal ulceration

Viral Conjunctivitis

23. Which of the following does not cause hemorrhagic conjunctivitis? *(Recent pattern Nov/Dec 2016)*
a. Adenovirus b. Coxsackie-24
c. Enterovirus-70 d. Influenza virus

24. Acute hemorrhagic conjunctivitis is caused by *(Recent pattern July 2016)*
a. Coxsakie A24 b. Newcastle conjunctivitis
c. Measels d. Mumps

25. Epidemic keratoconjunctivitis (EKC) is caused by?
a. Adenovirus 8 b. Adenovirus 11
c. Adenovirus 21 d. Adenovirus 26

Chlamydial Conjunctivitis

26. SAFE strategy is recommended for the control of: *(All India 2006)*
a. Trachoma b. Glaucoma
c. Diabetic retinopathy d. Cataract

27. Herbert's pits are seen in?
a. Trachoma
b. Acute endophthalmitis
c. Thyroid ophthalmopathy
d. Iridocyclitis

28. Which serotype of chlamydia causes conjunctivitis? *(PGI Nov 2012)*
a. A b. D
c. K d. L1

29. Follicular conjunctivitis is found in all except:
a. Herpes simplex conjunctivitis *(PGI Nov 2016)*
b. Drug induced
c. Adult inclusion conjunctivitis
d. Allergic conjunctivitis
e. Molluscum contagiosum

30. Percentage of silver nitrate used in Credes method
a. 0.5% b. 1%
c. 1.5 % d. 2%

31. Inclusion body conjunctivitis is true in all except
a. Self-limiting *(Recent pattern question Dec 2012)*
b. Present only in infants
c. Occurs while passage from birth canal
d. Caused by Chlamydia

32. Inclusion conjunctivitis is caused by – *(PGI Nov 2008)*
a. Chlamydia trachomatis
b. Chlamydia psittaci
c. Herpes
d. Gonorrhea

33. Pathognomonic of trachoma is – *(JIPMER 2003)*
a. Bulbar papillae b. Palpebral papillae
c. Bulbar follicles d. Palpebral follicles

34. Arlt's Line is seen in – *(Recent pattern Dec 2013)*
a. Vernal keratoconjunctivitis
b. Pterygium
c. Ocular pemphigoid
d. Trachoma

35. Cause of blindness in Trachoma – *(Recent pattern Dec 2013)*
a. Scarring b. Pannus
c. Chronic dacrocystitis d. Entropion

36. Drug of choice of trachoma is – *(Recent pattern Dec 2015)*
a. Penicillin b. Sulfonamide
c. Tetracycline d. Chloramphenicol

37. Egyption ophthalmia is – *(Recent pattern 2015)*
a. Spring catarrh b. Trachoma
c. Interstitial keratitis d. Xerophthalmia

Allergic Conjunctivitis

38. H.P. inclusion bodies in trachoma are seen in
a. Extracellular b. Intracytoplasmic
c. Intranuclear d. None

39. A Malnourished child from a poor scioceonomic status residing in overcrowded and dirty areas presents with a nodule around the limbus with hyperemia of surrounding conjunctiva in his left eye. He is also observed to have axillary and cervical lymphadenopahty. Which of the following is the most likely diagnosis? *(All India 2012)*
a. Phlyctenular conjunctivitis
b. Foreign body granuloma
c. Vernal keratoconjunctivitis
d. Episcleritis

40. Phlyctenular conjunctivitis is: *(PGI Nov 2012)*
a. Type I reaction b. Type II reaction
c. Type III reaction d. Type IV reaction
e. Type V reaction

41. Phlyctenular conjunctivitis associated with?
a. M. tuberculosis b. Proteus mirabilis
c. Klebsiella pneumoniae d. Gonococcus

42. Phlycten is due to – *(Recent pattern Dec 2014)*
a. Exogenous allergy b. Endogenous allergy
c. Viral keratitis d. Fungal keratitis

43. Phlyctenular conjunctivitis is caused by – *(Recent pattern Dec 2013)*
a. Chlamydia b. Staphylococcus
c. Pneumococcus d. Aspergillus

44. Features of vernal conjunctivitis are: *(PGI May 2010)*
a. Shield ulcer b. Horner-Trantas spots
c. Papillary hypertrophy d. Herbert pits
e. Pannus

45. Shield ulcer is seen in *(Recent pattern 2015)*
a. Phlyctenular conjunctivitis
b. Spring catarrh
c. Mycotic corneal ulcer
d. Herpetic ulcer

Most Recent Questions of 2019-2017 are given at the end

46. Feature(s) of Allergic conjunctivitis is/are all except: *(PGI Nov 2016)*

a. Itching
b. Papillary hyperplasia
c. Presence of abundant eosinophils in the discharge
d. Usually present throughout year
e. Mild hyperemia

47. Which of the following is not a feature of vernal conjunctivitis?

a. Maxwell lyon sign
b. Trantas spots
c. Follicles
d. Perilimbal papillary hypertrophy

48. Ramu age 10 years, present with itching in his eye, foreign body sensation and ropy discharge since several months. These symptoms are more prominent in summer. Most probable diagnosis is – *(AI 2004, AIIMS Nov 2001)*

a. Vernal conjunctivitis
b. Fungal keratoconjunctivitis
c. Viral conjunctivitis
d. Trachoma

49. Trantas spots are seen in – *(Recent pattern 2014)*

a. Vernal conjunctivitis
b. Eczematous conjunctivitis
c. Ophthalmia nodosa
d. Tularemia

50. Cobblestone appearance of conjunctiva is typically seen with – *(Recent pattern Dec 2013)*

a. Phlyctenular conjunctivitis
b. Foreign body
c. Spring catarrh
d. Trachoma

51. Vernal keratoconjunctivitis – *(Manipal 2009)*

a. Is usually unilateral
b. Eosinophil is common in the papilla
c. Is commoner in adults than in children
d. Causes corneal melting

52. Treatment of Vernal keratoconjunctivitis includes all except – *(Recent pattern question Dec 2012)*

a. Steroids
b. Sodium Cromoglycate
c. Olopatadine
d. Antibiotics

53. Giant papillary conjunctivitis is associated with: *(Recent pattern 2013)*

a. Hard Contact lens
b. Rigid gas permeable contact lens
c. Soft hydrophilic contact lens
d. INTACS

Conjunctival Degenerations

54. Which of the following is true about pterygium? *(AIIMS Nov 2013)*

a. Probe can be passed underneath the pterygium at the limbus
b. Associated with exposure to infrared radiation
c. Bare sclera technique has 30-80% recurrence
d. Elastotic degeneration with distortion of Descemet's membrane

55. Pterygium causes visual disturbances due to: *(All India 2005, DNB pattern 2012)*

a. Astigmatism
b. Myopia
c. Hypermetropia
d. Keratoconus

56. Which among the following drugs is used in the treatment of pterygium? *(Recent pattern 2014)*

a. Mitomycin C
b. Doxycycline
c. Actinomycin D
d. Ciprofloxacin

57. Pinguecula is best characterized histologically by *(Recent pattern 2015-16)*

a. Fatty degeneration
b. Hyaline degeneration
c. Elastotic degeneration
d. Fibrinoid degeneration

58. Pterygium is – *(AIIMS May 2008)*

a. A vascular anomaly
b. A connective tissue degeneration
c. An inflammatory condition
d. Associated with vitamin A deficiency

59. Stocker's line is seen in -

a. Pinguecula *(Recent pattern Dec 2013, AIIMS Nov 2010)*
b. Pterygium
c. Congenital ocular Melanosis
d. Conjunctival epithelial melanosis

Miscellaneous

60. Vitamin A deficiency causes all except:

a. Nyctalopia
b. Cataract
c. Xerophthalmia
d. Keratomalacia

61. Bitot spots are seen in?

a. Bulbar conjunctiva
b. Palpebral conjunctiva
c. Cornea
d. Eyelid

62. Changes seen in conjunctiva after vitamin A deficiency

a. Actinic degeneration
b. Hyperkeratosis of squamous epithelium
c. Stromal infiltration
d. Hyperplasia of goblet cells

63. Conjuntival adrenochrome is side effect of?

a. Adrenergic agonist
b. Carbonic anhydrase inhibitor
c. PG analogue
d. Parasympathomimetic

64. Most common malignant cancer of conjunctiva

a. Squamous cell carcinoma *(DNB pattern 2012)*
b. Basal cell carcinoma
c. Dermoid
d. Papilloma

65. Subconjunctival cyst is seen in – *(Recent pattern Dec 2015)*

a. Toxoplasmosis
b. Cysticercosis
c. Leishmaniasis
d. Chaga's disease

Most Recent Questions of 2019-2017

66. Most severe cause of conjunctivitis of newborn *(Recent pattern 2017)*

a. Gonococci
b. Chlamydia trachomatis
c. Streptococci
d. Staphylococci

67. Most common cause of conjunctivitis of newborn: *(Recent pattern 2017)*

a. Gonococci
b. Chlamydia trachomatis
c. Streptococci
d. Staphylococci

68. Which serotype of enterovirus most commonly causes Hemorrhagic conjunctivitis? *(Recent pattern 2017)*

a. Type 7
b. Type 70
c. Type 11
d. Type 23

69. Marker for limbal stem cell is *(JIPMER Dec 2018)*

a. ABCG2
b. PAX6
c. CD34
d. ABCA4

Most Recent Questions of 2019-2017 are given at the end

ANSWERS TO IMAGE-BASED QUESTIONS

1. Ans. (a) Desmarres lid retractor

2. Ans. (b) Eversion of upper eyelid

Desmarres lid retractor – is used primary for keeping the upper lid everted. In the upper lid, it is used for the posterior approach in ptosis repair and mullectomy for upper lid retraction.

In the lower lid, it can be used to pull it down when performing fat excision or repair of lower lid retraction in thyroid eye disease.

3. Ans. (c) Trachoma

Trichiasis (posterior misdirection of eyelashes arising from normal sites of origin) along with inferior pannus and a corneal epithelial defect can be seen in the image, indicating the occurrence of cicatricial stage of Trachoma.

4. Ans. (d) Chlamydia trachomatis

Trachoma is caused by Chalmaydia trachomatis (A,B,C serovars).

5. Ans. (b) Epilation of eyelashes

6. Ans. (d) Trachomatous trichiasis

Going by the FISTO classification of WHO, active inflammation signs and Arlt's line cannot be seen, so the above case cannot be TF, TI, TS.

Corneal epithelial defects can be seen, but corneal opacity has still not developed, thus the above patient can be graded as a case of TT.

7. Ans. (d) Duble pterygium

8. Ans. (b) Acute membranous conjunctivitis

9. Ans. (c) Corynebacterium diphtheria

10. Ans. (b) Pterygium

Ref: Khurana 6/e, p. 87

Pterygium is a wing shaped fold of conjunctiva encroaching upon the cornea within the interpalpebral fissure

11. Ans. (b) Astigmatism

Ref: Parson's 22/e, p. 184; Khurana 6/e, p. 87

In the first image (given in the question in NEET), the pterygium doesnot encroach upon the pupillary area and thus doesnot interfere with visual axis. In such cases, the vision becomes impaired due to induced astigmatism.

If the image given would have been the second – then the answer would have been Visual axis obstruction due to growth in the pupillary area, as is clearly visible in the image

ANSWERS TO MULTIPLE CHOICE QUESTIONS

12. Ans. (d) ABCG2

Ref: Text

13. Ans. (d) Corynebacterium xerosis

Ref: Khurana 6/e, p. 55, Yanoff 2/e, p. 469, 470, Jawetz 24 chapter 11

Refer text

14. Ans. (d) Diptheroids

Ref. Textbook of microbiology by Vasanthakumari p. 452

15. Ans. (c) Stratified non-keratinized squamous

Ref: Khurana Anatomy and physiology of eye 2/e, p. 368

16. Ans. (d) Conjunctiva

Ref: Parson's, 21/e, p. 162

17. Ans. (d) Cornea is infiltrated

In acute conjunctivitis, cornea is not involved. If cornea is involved, it becomes keratoconjunctivitis.

18. Ans. (b) Moraxella

Ref: Parson's 22/e, p. 169, Khurana 4/e, p. 61, Basic ophthalmology by RenuJogi (Jaypee) 4/e, p. 79/80

Moraxella lacunate (Moraxella axenfeld bacillus) is the most common/typical cause of angular conjunctivitis and angular blepharoconjunctivitis.

19. Ans. (a) Moraxella lacunata

Ref: Grayson's Diseases of the cornea (Mosby) 1997 p. 67

'Cytology of Conjunctival Scrapings reveals Polymorphonuclear cells in Bacterial infection, except Moraxella.

20. Ans. (a) Gonococcal

Ref: Parson's 21/e, p. 171

21. Ans. (d) High intraocular tension

Ref: Pocket atlas of ophthalmology 2/e, p. 68

22. Ans. (a) Easy to peel

A true membrane bleeds on peeling.

23. Ans. (d) Influenza virus

Ref: Kanski 8/e, p. 142; Copeland and Afshari's Principles and Practice of cornea, p. 351

Refer text

24. Ans. (a) Coxsackie A24

Ref: Parson's 20/e p. 162

25. Ans. (a) Adenovirus 8

Ref. Kanski 7/e, p. 142

Refer text

26. Ans. (a) Trachoma

Ref: Parson's 19/e, p. 595

Refer text

27. Ans. (a) Trachoma

Ref: Kanski 7/e, chapter 5

Refer text

28. Ans. (a) A, (b) D, (c) K

Ref: Khurana 5/e, p. 60-61; Parson's 20/e, p. 163-68

Refer text

29. Ans. None (i.e, All are correct)

Ref: Khurana 4/e, p. 69-70; Parson's 20/e, p. 162

Refer text

30. Ans. (b) 1%

31. Ans. (b) Present only in infants

Ref: Nema p. 125

Inclusion body conjunctivitis is caused by Chlamydia trachomatis and can affect both infants (ophthalmia neonatorum) and adults (adult inclusion body conjunctivitis).

32. Ans. (a) Chlamydia trachomatis

Ref: Khurana 4/e, p. 63, 68

Inclusion conjunctivitis – Chlamydia trachomatis serotypes D to K

33. Ans. (c) Bulbar follicles

Ref: Parson's 21/e, p. 173

"Follicles may be seen on bulbar conjunctiva (pathognomonic of trachoma).

34. Ans. (d) Trachoma

Ref: Parson's 21/e, p. 173

35. Ans. (a) Scarring

Ref: Parson's 21/e, p. 172-174

Rubbing of eyelashes of scarred eyelids against the cornea leads to corneal opacities and scarring and then to blindness.

36. Ans. (c) Tetracycline

Ref: Parson's 21/e, p. 174

Tetracycline ointment or Oral azithromycin are the drugs of choice for trachoma.

37. Ans. (b) Trachoma

Ref: Parson's 21/e, p. 172

38. Ans. (b) Intracytoplasmic

Halberstaedter Prowazeki-bodies are intracytoplasmic inclusion bodies.

39. Ans. (a) Phlyctenular conjunctivitis

Ref: Yanoff 3/e, p. 239; Parson's 21/e, p. 179.

Presence of a nodule around the limbus with hyperaemia of surrounding conjunctiva in a child with risk factors for tuberculosis suggests a diagnosis of phlyctenular conjunctivitis.

Malnutrition, poor, socioeconomic status (poverty), overcrowded and dirty surroundings and axillary/cervical lymphadenoathy are all pointers to a high risk of tuberculosis.

40. Ans. (d) Type IV reaction

Ref: Khurana 5/e, p. 75

It is believed to be a delayed hypersensitivity (Type IV-cell mediated) response to endogenous microbial proteins.

41. Ans. (a) M. tuberculosis

Ref. Parson's 20/e, p. 173

Refer text

42. Ans. (b) Endogenous allergy

Ref: Nema 3/e, p. 116

43. Ans. (b) Staphylococcus

Ref: Khurana 4/e, p. 77

44. Ans. (a) Shield ulcer, (b) Horner.. & (c) Papillary hypertrophy

Ref: Khurana 4/e, p. 74-76, 64-65; 3/e, p. 100; Parson's 20/e, p. 172; Kanski 6/e, p. 229

Refer text

45. Ans. (b) Spring catarrh

Ref: Parson's 21/e, p. 178; Khurana 4/e, p. 74-75

Remember, Shield cataract is an Anterior subcapsular cataract seen in Atopic dermatitis.

46. Ans. (d) Usually present throughout year

Ref: Khurana 4/e, p. 73-74; Parson's 20/e, p. 171-72

Allergic conjunctivitis may be perennial (throughout year) or seasonal

Clinical signs	Bacterial	Viral	Allergic	Chlamydial
1. Congestion	Marked	Moderate	Mild to moderate	Moderate
2. Chemosis	++	±	++	
3. Subconjunctival hemorrhages	±	±	–	–
4. Discharge	Purulent or Mucopurulent	Watery	Ropy/water	Mucopurulent
5. Papillae	±	–	++	±
6. Follicles	–	+	–	++
7. Pseudomembrane	±	±	–	–

Contd...

Clinical signs	Bacterial	Viral	Allergic	Chlamydial
8. Pannus	–	–	–(Except vernal)	+
9. Pre-auricular lymph nodes	+	++	–	±
Cytological Features				
1. Neutrophils	+	+(Early)	–	+
2. Eosinophils	–	–	+	–
3. Lymphocytes	–	–	+	–
4. Lymphocytes	–	–	–	+
5. Multinuclear cells	–	+	–	–
6. Micro-organisms	+	–	–	–

47. Ans. (c) Follicles

48. Ans. (a) Vernal conjunctivitis

Ref: Parson's 21/e, p. 178

Age 10 years (Male child), with Itching, foreign body sensation, Ropy discharge (characteristic of spring catarrh) and exacerbation during summer (characteristic of spring catarrh) is diagnostic for VKC.

49. Ans. (a) Vernal conjunctivitis

Ref: Parson's 21/e, p. 178

50. Ans. (c) Spring Catarrh

Ref: Parson's 21/e, p. 178

51. Ans. (b) Eosinophil is common in the papillae

Ref: Parson's 21/e, p. 178

- Histologically hypertrophied papillae show eosinophilic leukocytes in great numbers
- In addition infiltration with basophils, lymphocytes and plasma cells may also be seen.

52. Ans. (d) Antibiotics

VKC is a form of Allergic conjunctivitis – so no role of Antibiotics.

53. Ans. (c) Soft hydrophilic contact lens

Ref: Cornea by Mannis, 4/e, p. 542

Average time for development of GPC following soft contact lens – weeks to 8 months.
Average time for development of GPC following hard contact lens – up to 8 years.

54. Ans. (c) Bare sclera technique has 30–80% recurrence

Ref: Parson's 21/e, p. 181-182; Yanoff 2/e, p. 446-447

- Probe can be passed underneath a pseudo-pterygium
- UV rays are probably an etiological factor
- Pterygium is not elastotic degeneration and does not affect Descemet membrane. (Note that Pinguecula is an elastotic degeneration)

55. Ans. (a) Astigmatism

Ref: Basak Essentials of Ophthalmology 5/e, p. 153-156

56. Ans. (a) Mitomycin C

Ref: Kanski 7/e, p. 163

Used to reduce recurrence of pterygium.

57. Ans. (c) Elastotic degeneration

Ref: Kanski 8/e, p. 162, Yanoff 3/e, p. 248

Pinguecula is best characterized histologically by Elastotic degeneration.

58. Ans. (b) A connective tissue degeneration

Ref: Parson's 21/e, p. 181-182

59. Ans. (b) Pterygium

Ref: Parson's 21/e, p. 181, Yanoff and Duker 3/e, p. 248

Stocker's line is the line of iron deposition in the corneal epithelium seen adjacent to the head of the pterygium.

60. Ans. (b) Cataract

Ref: Kanski 7/e, p. 209

Xerophthalmia is the spectrum of ocular disease caused by lack of vitamin A.
It presents with symptoms of Night blindness (Nyctalopia), discomfort and loss of vision.

WHO Grading of Xerophthalmia

XN = night blindness
X1 A = Conjunctival xerosis –
dryness of the conjunctiva in the interpalpebral zone
loss of goblet cells
squamous metaplasia
keratinization
X1 B = Bitot spots –
triangular patches of foamy keratinized epithelium in the interpalpebral zone thought to be caused by Corynebacterium xerosis
X2 = Corneal xerosis = lusterless cornea
X3 A = corneal ulceration less than one-third
X3 B = corneal ulceration greater than one-third
(Keratomalacia is corneal melting by liquefactive necrosis resulting in perforation)

XS = Corneal scar
XF = Xerophthalmic fundus – yellowish dots in the peripheral fundus

61. Ans. (a) Bulbar conjunctiva

Ref. Kanski 7/e, p. 210

Bitot spots are triangular patches of foamy keratinized epithelium in the interpalpebral zone (elliptic space between the medial and lateral canthi of the two open lids) thought to be caused by Corynebacterium xerosis.

Interpalpebral zone-sclera and thus bulbar conjunctiva is seen as involved.

62. Ans. (b) Hyperkeratosis of squamous epithelium

Ref: Yanoff 2/e, p. 522

63. Ans. (a) Adrenergic agonist

Ref. Vaughan and Asbury's Ophthalmology 17/e, chapter 11

Epinephrine, external ocular side effects, including reflex conjunctival vasodilation, adrenochrome deposits, conjunctivitis, and allergic reactions.

Instilled epinephrine in the eye undergoes oxidation and gets converted into a pigment of the melanin family called adrenochrome.

Adrenochrome is found in lower conjunctival cul-de-sac. These deposits produce no symptoms because they are covered by squamous epithelium. However adrenochrome present in upper tarsal conjunctiva is stage horn shaped and may cause corneal abrasions. Adrenochrome may also be present on corneal epithelium in bullous keratopathy and raised IOP. Adrenochrome may last in conjunctiva for years.

64. Ans. (a) Squamous cell carcinoma

Ref: Abeloff's clinical oncology, p. 1019

SCC is the most common malignancy of the conjunctiva with an incidence of 0.025 to 3.5/100000 population.

65. Ans. (b) Cysticercosis

Ref: Khurana 4/e, p. 86

66. Ans. (a) Gonococci

Ref: Khurana 6/e, p. 77

'Untreated cases, especially gonococcal ophthalmia neonatorum, may develop corneal ulceration, which may perforate rapidly resulting in corneal opacification or staphyloma formation'

67. Ans. (b) Chlamydia trachomatis

Ref: Khurana 6/e, p. 77

Commonest cause of ophthalmia neonatorum – Chlaymdia trachomatis D to K serovars

68. Ans. (b) Type 70

Ref: Parson's 20/e, p. 162

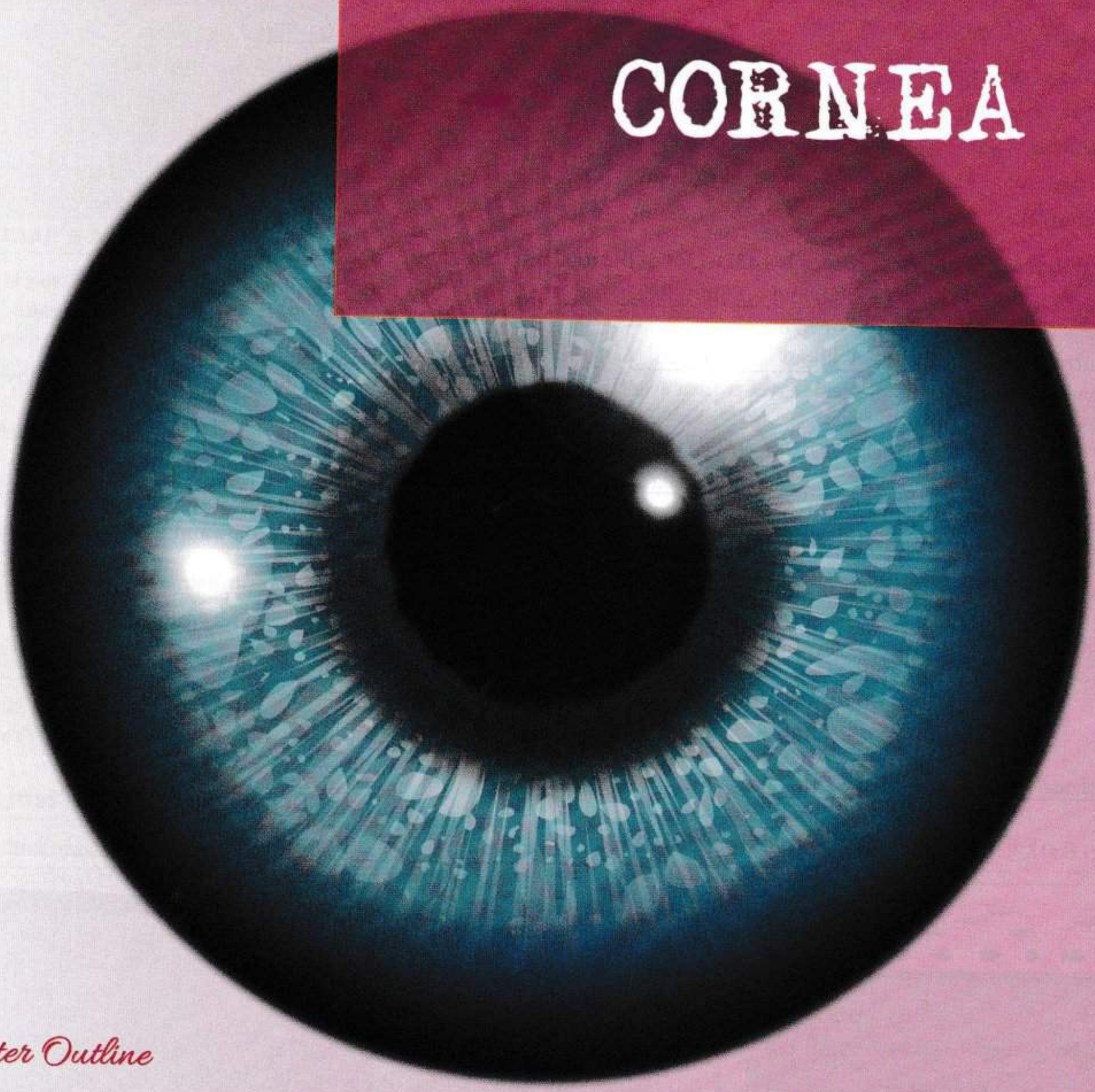
69. Ans. (a) ABCG2

Ref: Cornea by Mark J. Mannis 4/e, p. 7

NOTES

13

CORNEA



Chapter Outline

Anatomy
- Layers of Cornea (Anterior to Posterior)
- Nerve Supply of Cornea
- Factors Responsible for Maintenance of Corneal Transparency

Special Investigations related to Cornea
- Pachymetry
- Specular Microscopy
- Keratometry
- Corneal Topography
- Ultrasound Biomicroscopy (UBM)
- Corneal Esthesiometer
- Confocal Microscopy
- Dyes used for Corneal Staining

Microbial Keratitis
- Bacterial Corneal Ulcer
- Fungal Keratitis
- Acanthamoeba Keratitis
- Viral Keratitis
- Interstitial Keratitis

Corneal Dystrophies
- Epithelial
- Bowman Layer
- Stromal
- Endothelial

Corneal Ectasia
- Keratoconus

Miscellaneous

ANATOMY

- Cornea is a transparent, **avascular** structure forming 1/6th of the outer fibrous coat of eyeball.
- Cornea has the following 2 surfaces

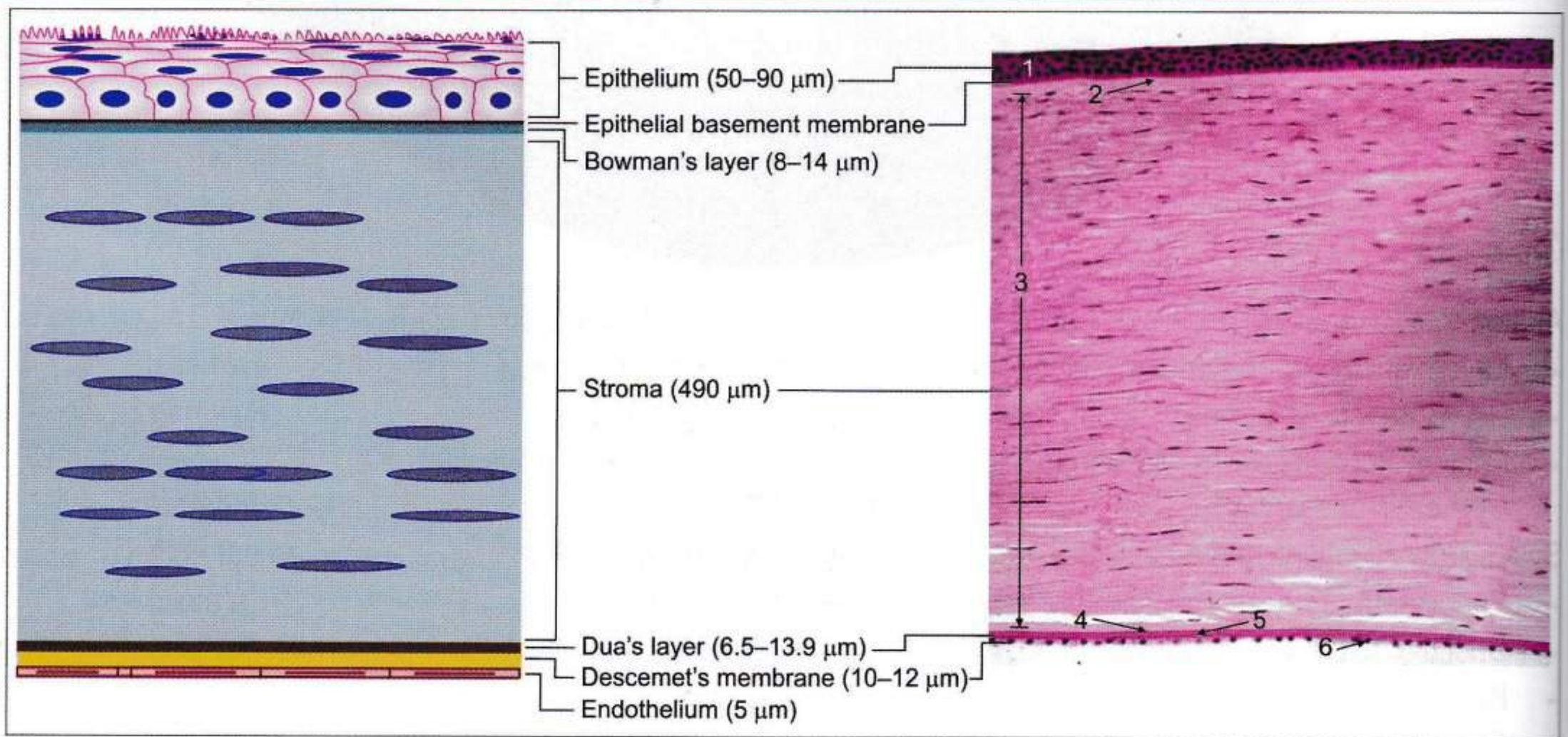
	Anterior corneal surface	Posterior corneal surface
Shape	Elliptical	Circular
Radius of curvature	7.8 mm	6.5 mm
Refractive power	+48 D	–5 D
Diameter		
Vertical	10.6 mm	11.7 mm
Horizontal	11.7 mm	11.7 mm

- Total **Refractive power** of cornea is **+43D.** (3/4 of the total refractive power of eye)
  Cornea is steep at birth (+53 D) and becomes flatter with age (+43D by 2 years).
- **Refractive index** of cornea is **1.376**.
- **Central corneal thickness** is about 520 microns. (Cornea is thicker in periphery about 670 microns)
- **Corneal size** - Horizontal diameter of cornea at birth is about 10 mm and reaches adult size of about 11.7 mm by 2 years of age.
  - **Microcornea** - Horizontal diameter less than 10 mm.
    It can be associated with Congenital rubella syndrome and Choroidal coloboma.
  - **Megalocornea** - Horizontal diameter >12 mm at birth or > 13 mm after 2 years of age.
    It can be associated with **M**arfan's syndrome, **E**hler–Danlos syndrome, **A**lport syndrome and **D**own syndrome.

Megalocornea	Buphthalmos
Enlarged cornea	Enlarged globe (which includes enlarged cornea)
Normal IOP	Elevated IOP
Normal endothelial cell density ✓	↓sed endothelial cell density
Cornea is clear	Hazy cornea

- Corneal shape–prolate (Aspheric)

Layers of Cornea (Anterior to Posterior)



Epithelium (50–90 μm)

- Non-keratinized Stratified squamous epithelium and consists of 5–6 layers of cell

Columnar[Q] cells
Form the basal cell layer
These cells are **capable of mitosis**

Wing or Umbrella cells
2–3 layers of polyhedral shaped cell

Squamous flattened cells
Two most superficial cell layers
Contains **microvilli** – help in **tear film stability**

- Complete turnover occurs in 6–8 days – replaced by growth from its basal cells.

Bowman's Membrane (8–14 μm)

- It is **not** a true membrane – not PAS positive.
- It **does not regenerate**[Q] – as it is an acellular layer consisting of collagen fibrils, thus, heals by scarring, leading to permanent loss of vision.

Correlate Box

PAS–Periodic Acid schiff staining

- Used to stain molecules with high carbohydrate content
- Periodic acid oxidizes → dialdehydes are formed → Schiff's reagent added → forms insoluble magenta colored complex
- **PAS** positive structures are
  B – basement membrane
  C – cerebrosides
  G – glycoprotein, glycolipid, glycogen
  False – fungi (live)
  Negative – neutral mucoprotein
  Pas – phosphorylated sugar

Stroma (Substantia Propria) (0.49 mm)

- It constitutes 90% of corneal thickness.
- It contains **mostly Type 1 collagen** and few Type 5 collagen. **MC** ground substance is **keratin sulphate**
- Contains keratocytes, macrophages, histiocytes and a few lymphocytes.

Dua's Layer (6.5–13.9 μm)

- It has been recently identified. It lies between stroma and Descemet's membrane (Pre-Descemet membrane).
- It is the toughest layer. (Previously, Descemet's membrane was considered as toughest layer).

Descemet's Membrane (10–12 μm)

- Its thickness varies with age (3 microns at birth and 10–12 microns in adults).
- It is secreted by endothelial cells throughout life
- It can regenerate.[Q]
- In the periphery, it ends at the anterior limit of trabecular meshwork known as **Schwalbe's line**.[Q]

Endothelium (5 μm)

- It consists of single layer of flat polygonal cells. Hexagonal
- **Most metabolically active** layer, contains an 'active- pump' mechanism ($Na^+ K^+$ ATPase) to maintain corneal dehydration.

Extra Mile

- Endothelial cells contain the highest number of mitochondria in eye after the photoreceptors
- **Corneal clouding** in corneal edema occurs due to accumulation fluid which increases the distance between the stromal collagen fibers
- Langerhans cells (antigen processing cells) are usually found in the peripheral corneal epithelium near Limbus. They may be seen in central corneal epithelium in corneal graft rejection
- **Corneal thickness** follows **a diurnal variation**–cornea(s) tend to be thicker in morning upon waking up due to decreased evaporation of tears caused by constant eyelid closure during sleep.

Nerve Supply of Cornea

Mnemonic

Nerve supply of cornea – TON

Trigeminal nerve —branch→ **O**phthalmic nerve —branch→ **N**asociliary nerve

Causes of Reduced Corneal Sensation

- **H** - Herpes keratitis
- **D** - Diabetes
- **L** - Leprosy
- **A** - Acoustic neuroma
- **C** - Contact lens wearers
- **T** - Overuse of topical drugs (Anesthetics, NSAID's, Beta blockers)
- **S** - Surgical trauma

Causes of Enlarged/Prominent Corneal Nerves

Local

- Keratoconus
- Congenital glaucoma
- Acanthamoeba keratitis
- Fuch's endothelial dystrophy

Systemic

- Leprosy
- Neurofibromatosis
- MEN type II B
- Refsum disease

Factors Responsible for Maintenance of Corneal Transparency

- Pre-corneal tear film and homogeneity of refractive index throughout the epithelium
- Avascularity of cornea
- Uniform arrangement of stromal lamellar collagen fibrils in a regular lattice
  - Collagen fibers are highly uniform in diameter (25–35 nm)
  - The distance between two corneal fibers is also highly uniform (41.5 nm), which is less than half of wavelength of light and thus, helps to maintain transparency by **destructive interference.**
- Relative state of corneal dehydration maintained by Endothelial pumps
- Normal intraocular pressure (IOP)
- Corneal Crystallins (Soluble proteins present in stromal keratocytes) reduce backscatter of light

Anomalies of Corneal Transparency

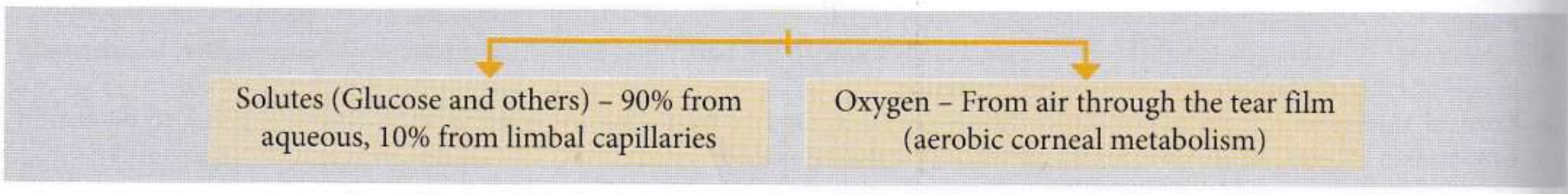
- **Anterior Embryotoxon**–Congenitally broad superior limbus
- **Posterior Embryotoxon**–thickening and anterior displacement of Schwalbe's line. It is associated with Axenfeld Rieger syndrome *(Refer page 218)*
- **Sclerocornea**–non inflammatory, non progressive sclera like clouding of cornea

Mnemonic

Causes of Neonatal Corneal Opacifiation – (MCG-SRT)

- Mucopolysaccharidoses
- CHED I / II
- Congenital Glaucoma
- Sclerocornea
- Rubella
- Birth Trauma

Corneal Nutrition


Solutes (Glucose and others) – 90% from aqueous, 10% from limbal capillaries
Oxygen – From air through the tear film (aerobic corneal metabolism)

Thus, it can be inferred that on the use of Contact lens, glucose supply will not be disrupted, instead due to lack of oxygen, glucose utilization or aerobic metabolism is restricted.

SPECIAL INVESTIGATIONS RELATED TO CORNEA

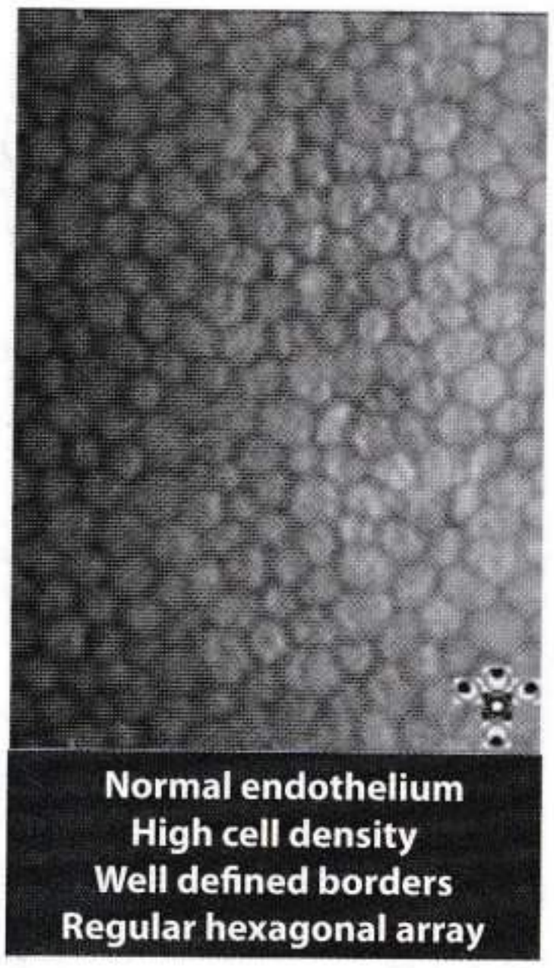
Pachymetry

- It measures **corneal thickness**.

Specular Microscopy

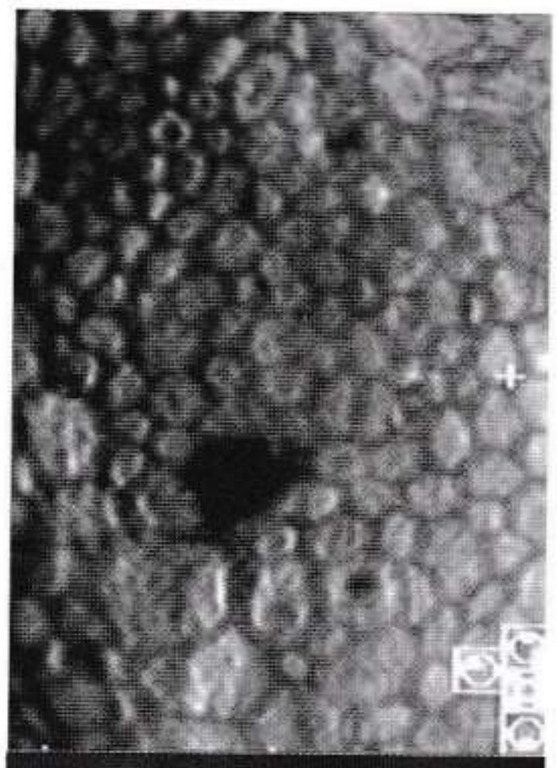
- It photographs **corneal endothelium** and measures endothelial cell density and cell morphology (size and shape).
- **Normal endothelial cell density in young adults is 2400–3000 cells/mm².**[Q]
- **Corneal decompensation occurs when more than 75% of adult age cells are lost. (<500 cells/mm²).**[Q]
- Alteration in cell morphology – variation in cell size, i.e. **polymegathism** and cell shape, i.e. **pleomorphism** (Decrease in hexagonality <70–80% with a concomitant increase in the number of cells) are indices of endothelial stress, and occur as compensatory mechanisms to decompensation.

Interpretation of Findings



Normal endothelium
High cell density
Well defined borders
Regular hexagonal array

Very low density
High surgical risk



Polymegathism
Extended wear contact lenses

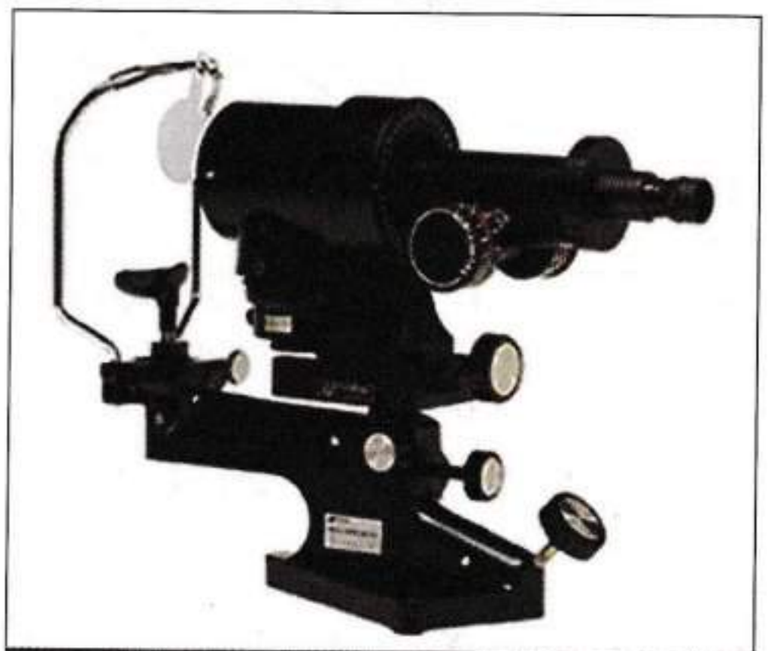
Keratometry

It **measures radius of curvature**[Q] of anterior corneal surface.

It is based on the fact that the anterior surface of the cornea act as a convex mirror and the size of the image formed varies with its curvature.

Interpretation of Findings (Refer Image-based Question)

- In spherical cornea mires are seen as perfect sphere.
- Horizontally oval mires are seen in with-the-rule astigmatism.
- Vertically oval mires are seen in against-the-rule astigmatism.
- Pulsating mires are seen in keratoconus.
- Mirification of mires is seen in advanced keratoconus.



Bausch and lomb Keratometer

Corneal Topography

It is the study of the **shape of the corneal surface** and helps in determining the refractive status of the eye. It can be measured by

Videokeratoscopy

- It is based on **Placido disc principle** (multiple rings of alternating black and white color) and used for corneal topography.
- It measures almost 95% of the total corneal surface.

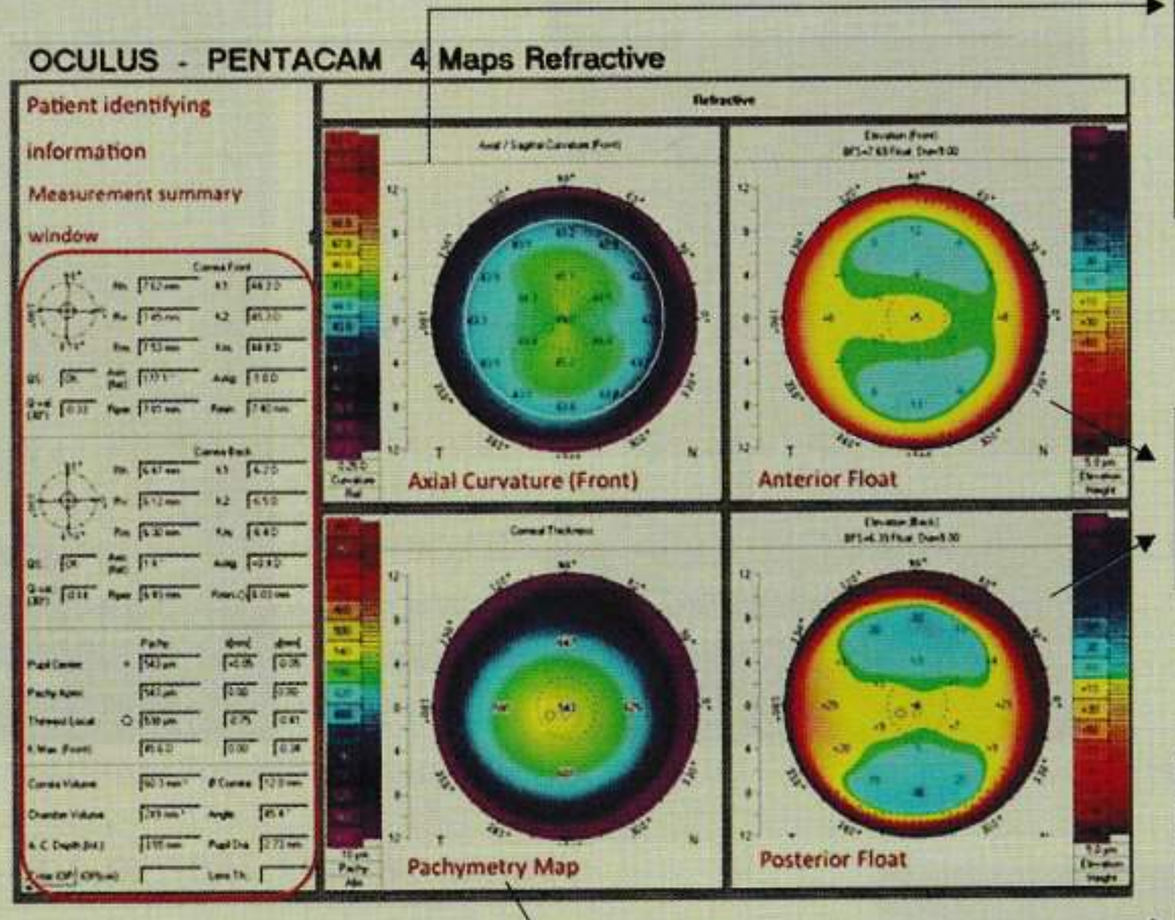
Orbscan

- It is based on **Slit scanning principle** and obtains corneal topography (anterior and posterior surface) along with corneal thickness.

Pentacam

- It is based on **Scheimpflug principle**.
- It is able to perform the following functions in around 2 seconds
  - Anterior segment imaging (from cornea to posterior surface of lens)
  - Pachymetry
  - Corneal topography (anterior and posterior surface elevation)

EXTRA MILE


OCULUS - PENTACAM 4 Maps Refractive
Patient identifying information
Measurement summary window
Axial Curvature (Front)
Anterior Float
Pachymetry Map
Posterior Float
Axial curvature/Sagittal Map - depicts the curvature of anterior surface of cornea in dioptres for each point. Warmer colors denote steepening, cooler colours represent flatter areas
Elevation maps – warmer colors denote elevated cornea and cooler colors denote depressed areas
Pachymetry map – indicates corneal thickness Warmer colors indicate thinning and cooler colors indicate thickening
Red and yellow are warm colors and shades of blue and green are cool colors

Uses of Pentacam

- Keratoconus screening
- Monitoring the progression and treatment of corneal ectasia
- Screening before refractive surgeries
- Post keratoplasty astigmatism evaluation
- Evaluation of ocular surface disorders inducing astigmatism

Ultrasound Biomicroscopy (UBM)

- It uses **35–50 MHz probe**.Q Its depth of penetration is 4 mm.
- It can be used to measure corneal thickness, anterior chamber depth, and can be used to evaluate angle parameters.

Corneal Esthesiometer Q

- It measures corneal sensation
- Also measure by the corneal Blink reflex (afferent pathway by trigeminal nerve and efferent pathway formed by facial nerve), done using a wisp of cotton.

Confocal Microscopy

- It is a noninvasive technique for in vivo imaging of all layers of living cornea.

Dyes used for Corneal Staining

Fluorescein

- It is used for staining **denuded epithelium** (epithelial defect) in corneal ulcers.
- It stains the **base** of the corneal ulcer, and is seen as an area of green color under cobalt blue light examination on slit lamp.

Other uses:

- Applanation tonometry
- Jones dye disappearance test for assessment of lacrimal passage functional patency
- Seidels test - to detect wound leak, bleb leak or in cases of corneal perforation
- For diagnosing dry eye (Tear break up time - TBUT, conjunctival and corneal staining)

Rose Bengal

- 1% solution is used to stain **devitalized tissue**. It stains **red** the **edges/margin** of the corneal ulcer.
- It is a derivative of fluorescein. It is used for evaluation of other ocular pathologies like herpetic epithelial dendrites, superficial punctate keratitis, meibomian gland dysfunction and dysplastic or metaplastic squamous cells. It can cause stinging upon instillation leading to patients discomfort.
- Rose Bengal is **virucidal**, thus culture swabs must be taken before staining.

Lissamine Green

It stains membrane damaged or devitalized cells. It is unique among these three as it does not stain healthy ocular surface cells.

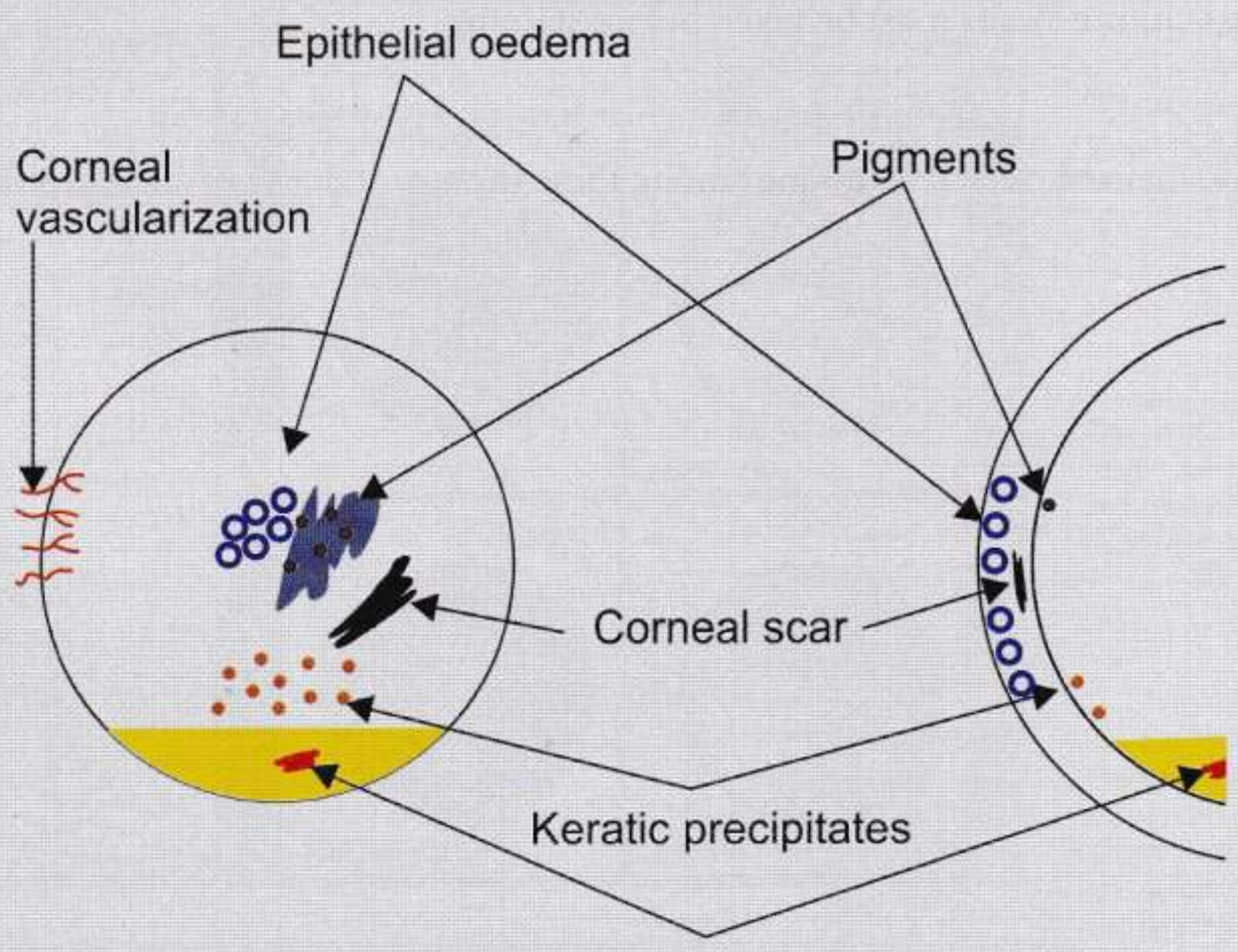
Alcian Blue

It stains **mucin** and **filaments**.

BONUS PAGE 7

DOCUMENTATION OF CLINICAL SIGNS

- Black-Outline limbus scars/opacities
- Brown-Melanin or iron pigmentation
- Blue-Edema
  - Shading-Diffuse
  - Circles-Epithelial
  - Wavy lines-Folds in Descemet's membrane
- Red-Blood vessels
  - Wavy lines begin outside limbus-Superficial vessels
  - Straight lines begin at limbus-Deep vessels
- Yellow-Hypopyon keratic precipitates



MICROBIAL KERATITIS

- **Keratitis** – inflammation of the cornea
- **Abrasion** – discontinuity in the corneal surface
- **Corneal ulcer** – discontinuity in the corneal epithelial surface associated with cellular infiltration and necrosis of the anterior layers of cornea.

Bacterial Corneal Ulcer

Most Common Organism causing bacterial corneal ulcer in

- World – *Staphylococcus aureus*
- India – *Streptococcus pneumoniae, Staphylococcus epidermidis*
- Contact lens users[Q] – *Pseudomonas*
- Diabetics/Alcoholics/Debilitated patients – *Moraxella*
- Following LASIK–Atypical Mycobacteria (MC–*Mycobacterium chelonae*)
- With Nasolacrimal duct blockage/Dacryocystitis – *Streptococcus pneumoniae*

Mnemonic

Organisms that can penetrate intact[Q] cornea include (**H**igh **L**evel **CNS**)

- ***H**aemophilus aegyptius*
- **L**isteria
- ***C**orynebacterium diptheriae*
- ***N**eisseria gonorrhoea*
- ***N**eisseria meningitides*
- **S**higella

Pathogenesis

Initial stages – saucer shaped ulcer with the walls projecting above the normal surface of cornea due to stromal lamellar edema

↓

Progressive stage – a polymorphonuclear response is mounted

↓

Regressive stage – floor and edges become smooth and transparent and corneal vascularization occurs

↓

Healing stage – cicatrization occurs with the formation of a scar (permanent if Bowman's membrane destroyed)

Clinical Features

Symptoms

The patient presents with Pain[Q], lacrimation[Q], foreign body sensation[Q], conjunctival injection[Q] (red eye), photophobia[Q] and blurred vision[Q] – **Sudden Painful loss of vision with Red eye (similar to Acute angle closure glaucoma and Acute anterior uveitis).**

Signs

- Keratouveitis – due to diffusion of toxins in the anterior chamber
- **Hypopyon** – pus in the anterior chamber – always **Sterile**[Q] and **Mobile**[Q]
- Ectatic cicatrix – due to thinning of cornea, it bulges forward
- **Anterior staphyloma** – an ectatic cicatrix with incarceration of the iris
- **Desmatocoele** – herniation of Descemet membrane
- **Perforation** – sudden exertion by patient leads to rise in IOP, where the weak floor of the ulcer gives way leading to perforation, causing

↓ **Anterior synechiae**
Small perforation pluged by iris in touch with cornea forming a Pseudocornea

↓ **Iris** prolapse
If perforation is large

↓ **Anterior capsular cataract**
If perforation infront of pupillary area lens comes in contact of ulcer leading to formation of opacity

- Expulsive Hemorrhage – due to sudden change in IOP, blood vessels dilate and rupture
- Purulent endophthalmitis leading to Phthisis

Hypopyon corneal ulcer

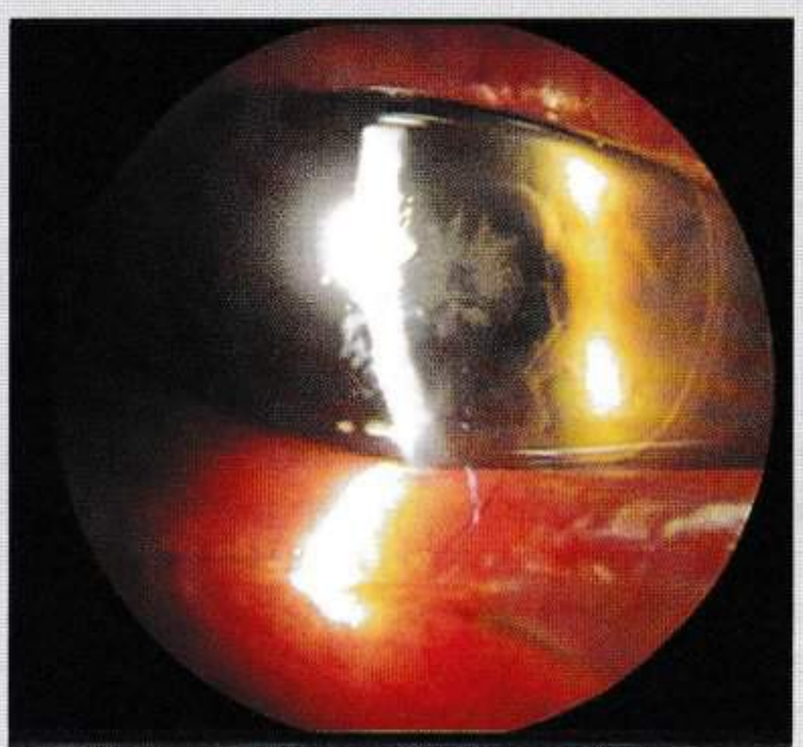
Perforation of peripheral corneal ulcer with Prolapse of iris

HIGH YIELD

Specific Clinical Presentations

- **Pneumococcus** causes characteristic **"hypopyon corneal ulcer"** also known as Ulcus Serpens[Q]
- **Pseudomonas** pyocyanea and Gonococcus can cause corneal ulcer with hypopyon
- Corneal ulcer with a **green colored discharge** is characteristic for **Pseudomonas**. It may cause ring ulceration with higher chances of Perforation
- Nocardia causes **"Wreath pattern appearance"**, **Cracked wind shield appearance**, **pin size infiltrates**, brushfield border and satellite lesions.
  Nocardia can resemble fungal keratitis clinically[Q]
- **Atypical Mycobacteria** causes "Cracked wind shield appearance" or they may cause Infectious crystalline keratopathy
- Nonsuppurative bacterial corneal ulcers can be caused by Actinomyces, Nocardia, Moraxella, Bacteroides
- **Microsporidia** cause
  - Chronic stromal keratitis – in Immunocompetent patients
  - Keratoconjunctivitis – in Immunocompromised - AIDS
- Streptococcus viridans causes **infectious crystalline keratopathy**.

Wreath-pattern ulcer with pin head infiltrates keratitis



Needle-like crystalline pattern with a snowflake or ice crystal appearance of white opacities within the corneal stroma. Most frequently occurs in Corneal grafts

Treatment

For the management of all cases of corneal ulcer, microbiological workup is mandatory in all cases with 15 No. blade is used to scrape the base and edges of the corneal ulcer before commencing any pharmacological treatment

↓

Sample sent for Gram/Geimsa staining and Culture

↓

Fortified topical Antibiotics are usually indicated in severe cases according to the sensitivity and the culture reports + **topical Cycloplegics**[Q] (for associated uveitis)

↓

In case of an Impending perforation, Doxcycline may be given, and the ulcer may be treated with Cyanoacrylate glue, Bandage contact lens, patch graft

Topical steroids are **contraindicated** in Bacterial corneal ulcer
Pad and Patch, Bandaging is **Contraindicated**

Correlate Box

Cuture media for various organisms

Culture medium	Growth
Routine	
Soybean casein digest broth (trypticase soy broth)	Saturation of swabs
Blood agar plate	• Aerobic bacteria • Facultative anaerobic bacteria • Fungi
Chocolate agar plate	• Aerobic bacteria • Facultative anaerobic bacteria • *Neisseria* • *Haemophilus* • *Moraxella*
Thioglycolate broth	• Aerobic bacteria • Anaerobic bacteria
Sabouraud's dextrose agar plate with antibiotic	• Fungi • Nocardia
Brain Heart infusion broth plate with antibiotic	• Fungi • Nocardia
Special	
Cooked meat broth	Anaerobic bacteria
Schaedler agar	Anaerobic bacteria
Thayer Martin Blood agar plate Brucella blood agar plate	Neisseria
Lowenstein-Jensen media	*Myocobacteria species*
Middlebrook-Cohn agar	*Myocobacteria/Nocardia*

Contd...

Stains for corneal and conjunctival scrapes

Stain	Organism
Gram	Bacteria, fungi, *Microsporidia*
Giemsa	Bacteria, fungi, *Acanthamoeba, Microsporidia*
Calcofluor white (fluorescent microscope)	*Acanthamoeba*, fungi, *Microsporidia*
Acid-fast stain (AFB) e.g. Ziehl-Neelsen, Auramine O (fluorescent)	*Mycobacterium, Nocardia* spp.
Grocott-Gömöri methenamine-silver	Fungi, *Acanthamoeba, Microsporidia*
Periodic acid-Schiff (PAS)	Fungi, *Acanthamoeba*

Staphylococcus on blood agar
Golden shiny colonies

Fungal Keratitis

- Most common organism is ***Aspergillus fumigatus*** (**filamentous** fungi with **septate** hyphae).
- Others commonly seen are Candida albicans and Fusarium.
- Most common risk factor is **injury by vegetative matter** (most commonly in farmers) like crop leaf, thorn or wooden stick or prolonged use of unwarranted steroids.

Clinical Features

Symptoms are same as bacterial corneal ulcer but are less pronounced.

HIGH YIELD

Signs

"SIGNS ARE MORE PROMINENT THAN SYMPTOMS" in fungal ulcer (See IBQ 1 for image)

- Greyish white **dry** looking ulcer
- **Elevated** rolled out **feathery** and hyphate **margins**
- Feathery finger like extension into surrounding stroma under intact epithelium
- Sterile immune ring of **Wesseley**
- Multiple **satellite lesions**
- **Nonsterile** (infected) and **Immobile hypopyon** (Pseudohypopyon) containing fungus
- Perforation is rare.
- Corneal vascularization is conspicuously absent.

Specific Signs

- Curvularia lunata (Dematiaceous fungi) causes brown pigmentation
- Yeasts cause **Collar button configuration** ulcer

Treatment

Corneal scrapings sent for Smear on KOH wet mount and culture with Sabourauds dextrose agar (with 50 mg/ml gentamicin).
The mainstay of treatment is the use of antifungal drops

- Natamycin 5% (Polyene) is FDA approved for use in Filamentous fungi - Aspergillus, Fusarium.
- Amphotericin B 0.15% topical drops (Polyene) or Fluconazole 0.3% (Triazole) are used as initial therapy for candida infections
- Oral posaconazole, a new generation triazole has been successful eradicating deep infections of resistant Fusarium.
- Subconjuctival antifungals are not generally used because the produce severe pain and some might even induce tissue necrosis.
- Steroids are contraindicated.
- Topical cycloplegics given as adjuvant therapy

Acanthamoeba Keratitis

Risk Factors

- Commonly seen in **contact lens wearers**[Q] (usual source is the **contaminated saline solution** used to store or clean the lenses or if tap water is used to clean them)
- Immunocompromised individuals
- Following trauma[Q]
- Acquired from swimming pool.[Q]
- Orthokeratology

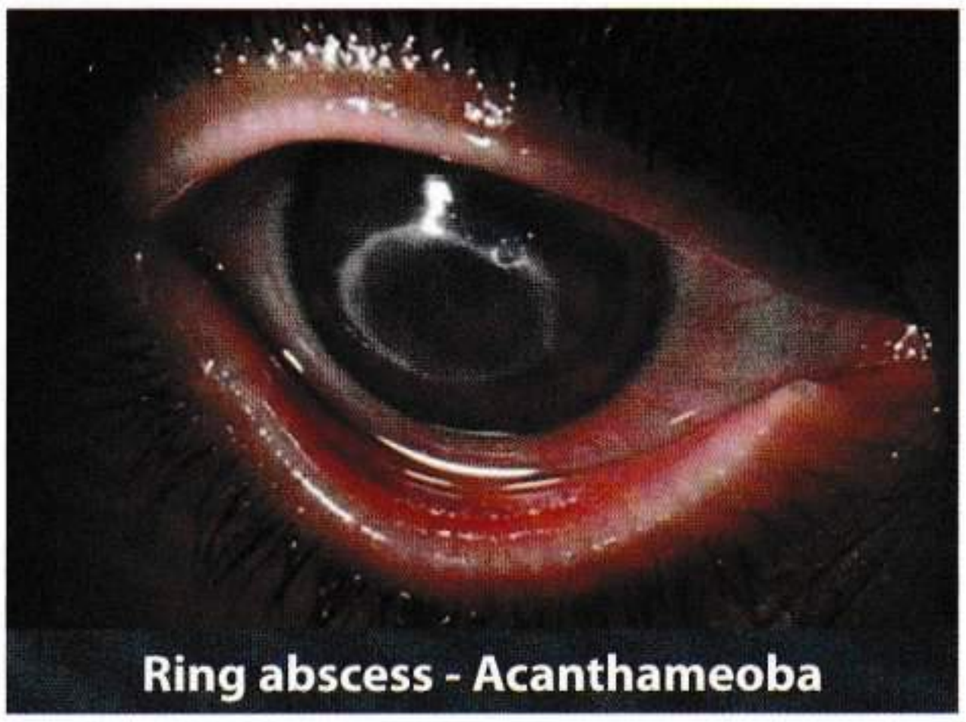
Clinical Features

Symptoms

- Symptoms are more than Signs.
- Patients usually present with very severe pain out of proportion to the ocular involvement.

Signs

- Typical reticular pattern
- **Radial keratoneuritis**–perineural infiltrates seen during the first 4 weeks–Pathognomonic
- **Pseudodendrites**–mistaken with herpes simplex keratitis
- Severe cases may have central or paracentral ring shaped lesion **(Ring abscess)** and hypopyon
- Limbitis



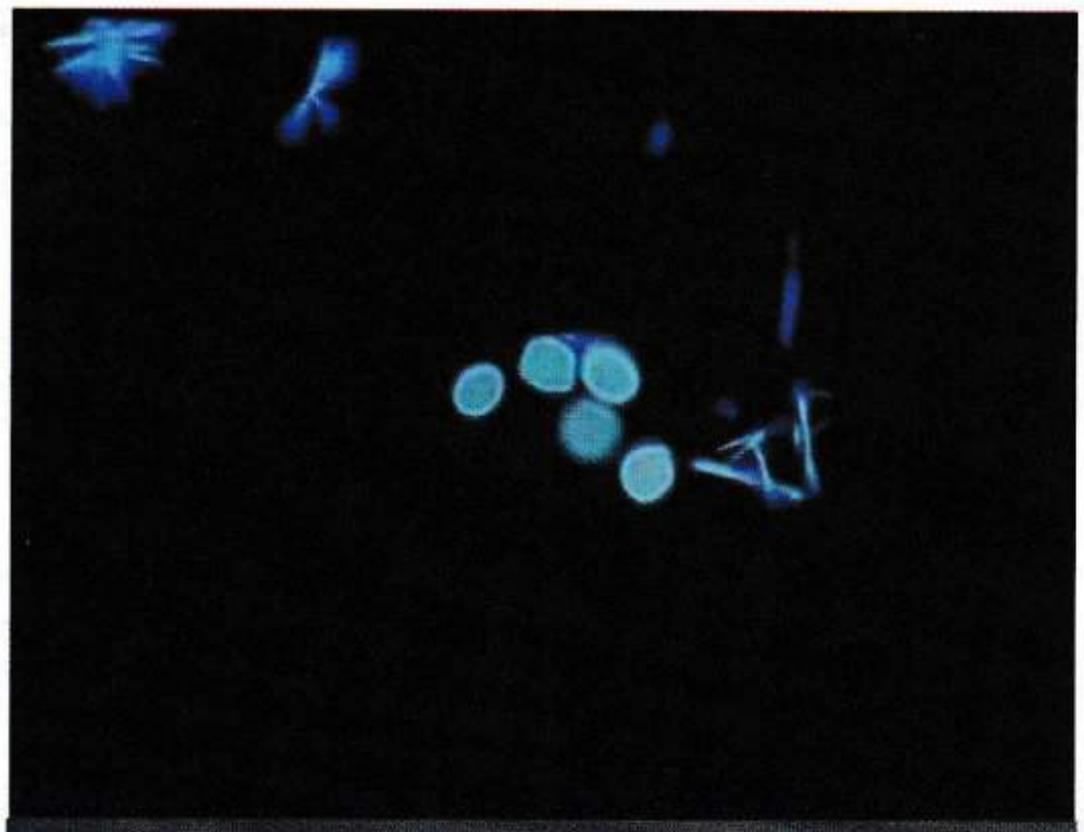
Ring abscess - Acanthameoba

Investigations

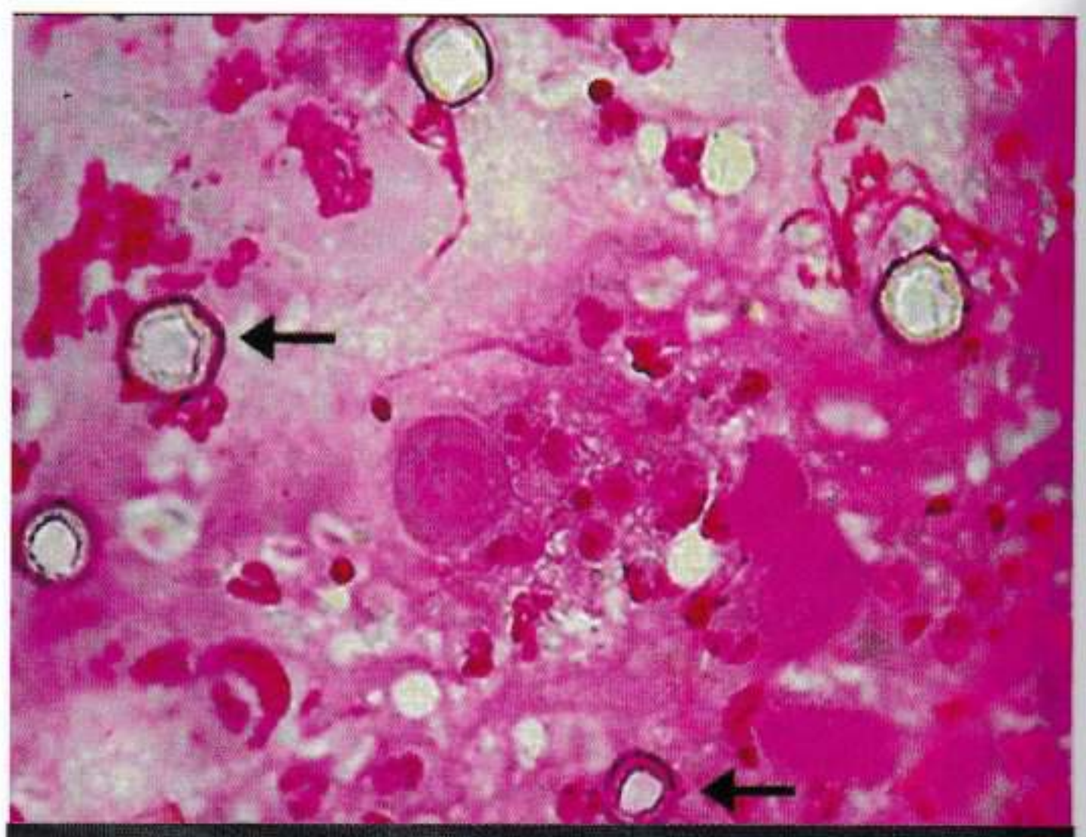
- Staining of corneal scrapings with **Calcoflour white**[Q] or Fluorescein conjugated. Concanavalin A to demonstrate cysts
- Culture[Q] on **Non-nutrient agar enriched with *E. coli***

Treatment

- Debridement of the ulcer base
- Topical amoebicides (**cysticidal**)
  - DOC: Polyhexamethylene biguanide **(PHMB 0.02%)** – inhibit membrane synthesis
  - Chlorhexidine digluconate (0.02%) - inhibit membrane synthesis
  - Propamidine – inhibit DNA synthesis



Cysts of *Acanthamoeba* species stained with the optical whitening agent calcofluor white and examined using ultraviolet epifluorescence



Acanthamoeba cysts
Gram's staining-double walled polygonal cysts

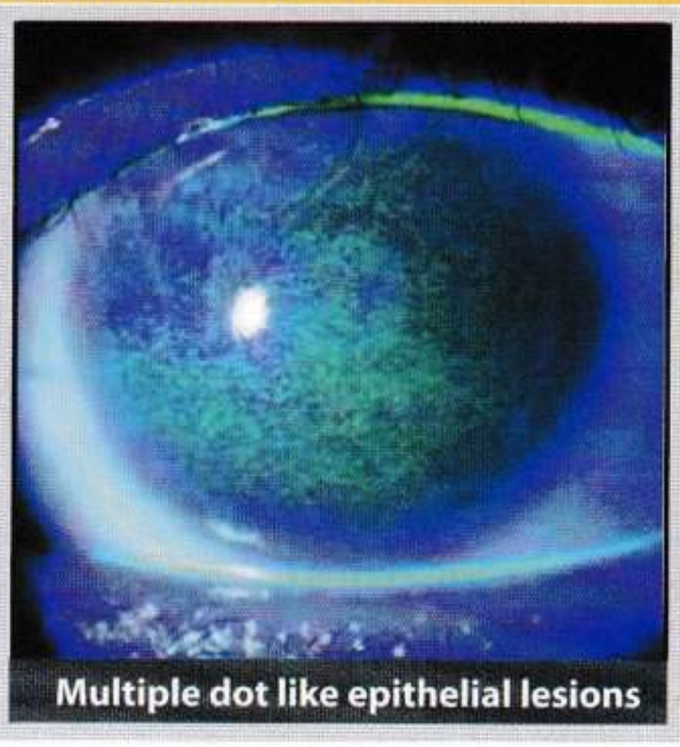
Viral Keratitis

Herpes Simplex Keratitis

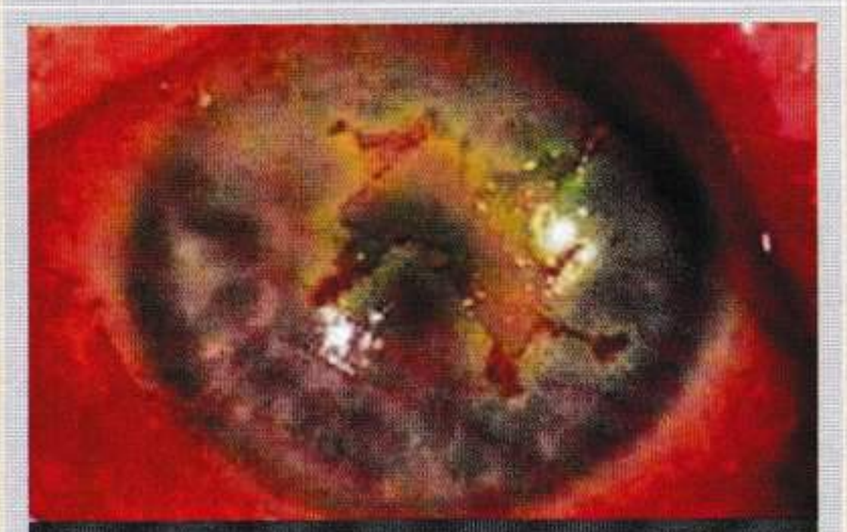
Herpes Simplex Keratitis

- Primary infection
  Mild and self-limited
  Blepharitis and follicular conjunctivitis may develop
- Recurrent infection (HSV 1)
  Severe disease, Contagious
  Keratitis

Clinical Features

Lesion	Pathogenesis	Description	Treatment
		Epithelial Keratitis	
Superficial Punctate Keratitis	Due to active viral infection	 Multiple dot like epithelial lesions	• 3% acyclovir ointment (5times/day) • Epithelial debridement • Topical Steroids are contraindicated

Contd...

Lesion	Pathogenesis	Description	Treatment
Dendritic ulcer	Due to active viral infection	**Linear branching pattern with terminal knobs/buds – seen on fluorescein staining (Green)**	• 3% acyclovir ointment (5times/day) • Epithelial debridement • Topical Steroids are contraindicated
Geographic ulcer	Due to active viral infection	 **Amoeboid shaped configuration due to inadvertent use of Topical Steroids – margins stained with Rose Bengal dye**	• 3% acyclovir ointment (5times/day) • Topical Steroids are contraindicated
Neurotrophic ulcer/ Metaherpetic keratitis	Non infectious – due to decreased corneal sensitivity caused by denervation or drug toxicity	Shows 'Reverse Staining'	Lubricants, patch grafting, bandage contact lens, tarsorrhaphy
Stromal keratitis			
Immune stromal keratitis/ Interstitial keratitis	Type 3 Immune mediated response to HSV antigen	Manifests as punctuate stromal opacities; immune ring deposition; unilateral, sectoral stromal neovascularization	Topical antiviral and steroids
Necrotizing keratitis	Active viral stromal infection	Epithelial defect, ulceration, necrosis and stromal infiltration ↓ Uveitis and trabeculitis causing recalcitrant glaucoma	Topical steroids and antiviral
Endothelitis			
Disciform keratitis	Type IV hypersensitivity	Sharply demarcates **Disc shaped** area of stromal edema	Topical steroids plus antiviral
Diffuse endothelitis		Diffuse stromal edema with scattered KP's	Topical steroids

Hallmark of HSV keratitis – reduced corneal sensation

EXTRA MILE

Differential diagnosis of Dendritic ulcer

- Herpes zoster keratitis
- Healing corneal abrasion
- Acanthamoeba keratitis
- Epithelial rejection in a corneal graft
- Tyrosinaemia type 2
- Use of soft contact lens

Herpes Zoster Ophthalmicus

Herpes zoster ophthalmicus (HZO) describes Shingles involving the dermatome supplied by the ophthalmic division of the 5th cranial nerve.

It is more common with

- Old age – 6th and 7th decade
- Hutchinson sign – involvement of the tip of nose supplied by nasociliary nerve indicates higher risk for ocular involvement
- Immunocompromised patients.

Clinical Features

- Epithelial **Pseudodendrtic keratitis** (no terminal knobs or buds) – develop 2 days after rash.
- **Nummular keratitis** – fine granular subepithelial deposits surrounded by a halo of stromal haze. This is the earliest sign of stromal involvement
- Stromal interstitial keratitis
- **Disciform keratitis**
- Mucous plaque keratitis – chronic cases
- Anterior uveitis – Keratouveitis
- Sclerokeratitis – least common[Q]
- **Neurological complications** – cranial nerve palsies (3rd nerve most common), Optic neuritis and encephalitis
- Episcleritis, Scleritis, Iritis, glaucoma
- **Post-herpetic neuralgia** – pain that persists for more than one month after the rash has resolved – worse at night.
- Eyelid signs – scarring, entropion, ectropion.

Nummular keratitis

Coin-shaped subepithelial areas of inflammation

Treatment

- Oral Acyclovir (800 mg 5 times a day for 10 – 14 days) or Famciclovir (500mg three times a day for 3 days) started within 72 hours.
- HZO with HIV is treated with **Intravenous** Acyclovir.

Correlate Box

Human herpesviruses of medical importance		
Abbreviation	**Nomenclature**	**Disease caused**
HSV-1	Herpes simplex type-1	Oral, ocular, genital herpes, whitlow
HSV-2	Herpes simplex type-2	Genital, oral, ocular herpes, whitlow
VZV	Varicella zoster virus	Chickenpox, herpes zoster (shingles)
CMV	Cytomegalovirus	Retinitis, range of systemic diseases
EBV	Epstein–Barr virus	Infectious mononucleosis
HHV-6	Human herpesvirus-6	Exanthem subitum (roseola)
HHV-7	Human herpesvirus-7	Exanthem subitum (roseola)
KSRV	Kaposi's sarcoma-related virus	Kaposi's sarcoma

Varicella Zoster Virus (VZV)

- HHV 3 (Herpesviridae), smallest alpha virus with Icosahedral capsid and glycoprotein containing lipid envelope which aids cell entry
- Primary infection causes – Varicella (chicken pox)
- Reactivation causes – Herpes Zoster (shingles)
- Virus spreads along the trigeminal nerve and causes the characteristic unilateral exanthematous vesicular rash
- TZANCK smear
  - Lipschutz bodies – eosinophilic intranuclear inclusions – in VZV
  - Cowdry type A bodies – eosinophilic intranuclear inclusions – in HSV

CORNEAL DYSTROPHIES

- Primary corneal disease (not associated with any systemic disease) Noninflammatory, Progressive, usually bilateral, AD, Opacifying disorders presenting in 1st- 2nd decade

Epithelial	
C – Cogan's epithelial basement membrane dystrophy/Map Dot **M** – Meesmann epithelial dystrophy **L** – Lisch epithelial dystrophy	***Most Common corneal dystrophy*** *(Nonprogressive, due to Keratin gene mutation* AD/***XLD***
Bowman layer	
R – Reis Bucklers dystrophy/CDB I / GCD III **S** – Schnyder central crystalline dystrophy **T** – Thiel Behnke dystrophy/CDB II	Fish Net blue with masson trichrome. Corneal Lipid metabolism disorder Honeycomb pattern of opacities
Stromal	
L – Lattice corneal dystrophy I/Biber Haab Dimmer Lattice corneal dystrophy II/Finnish Lattice corneal dystrophy IIIA **G** – Gelatinous Drop like dystrophy/Japenese **G** – Granular corneal dystrophy I/Groenouw Granular corneal dystrophy II **M** – Macular dystrophy/Groenouw II **F** – Francois central cloudy dystrophy	neuropathy seen 70 to 90 years ***AR***, Mulberry like appearance] Amyloid deposit – stained by Congo Red **Hyaline deposit – stained by Masson Trichrome stain**[Q] Red. Hyaline + Amyloid deposit ***AR*, Least common corneal dystrophy**[Q] GAG - stains with Alcian blue & Colloidal Iron Inborn error of keratin sulphate metabolism
Endothelial	
F – Fuch's endothelial dystrophy **P** – Posterior Polymorphous corneal dystrophy **C** – Congenital hereditary endothelial dystrophy I Congenital hereditary endothelial dystrophy II	**Cornea Guttata – wart like excrescences** **Both have AR inheritance and have perinatal onset**

Mnemonic

- **Recurrent Corneal Erosions – CTRL I**
  Cogan/Thiel Behnke/Reis Buckler/Lattice I
- Disorders of metabolism - MMS
  Meesman/Macular/Schnyder

CORNEAL ECTASIAS

Keratoconus

It is a non-inflammatory progressive disorder characterized by **inferior corneal steepening** where the cornea assumes a conical shape.

Etiology

- Congenital weakness of cornea
- Secondary to Trauma, Vernal keratoconjunctivitis, Down syndrome

Clinical Features

Symptoms

The condition is usually bilateral, though the presentation during puberty is Unilateral with **Myopia and irregular astigmatism**.

Signs

- **Hallmark** – central or paracentral stromal thinning with apical protrusion (apex of the cone is always slightly below the cornea)
- Direct ophthalmoscopy – **Oil droplet reflex**/Charleaux sign
- Retinoscopy – irregular Scissoring reflex
- **Vogt striae** – vertical, deep stromal stress lines – pathognomonic
- **Fleischer ring** – epithelial iron (hemosiderin) deposition around the base of cone
- **Munson sign** – bulging of lower eyelid on downgaze
- **Rizutti's sign:** Light thrown temporally falls in an arrow head pattern on the nasal limbus
- **Acute hydrops** – sudden influx of aqueous into the cornea due to descemet membrane rupture

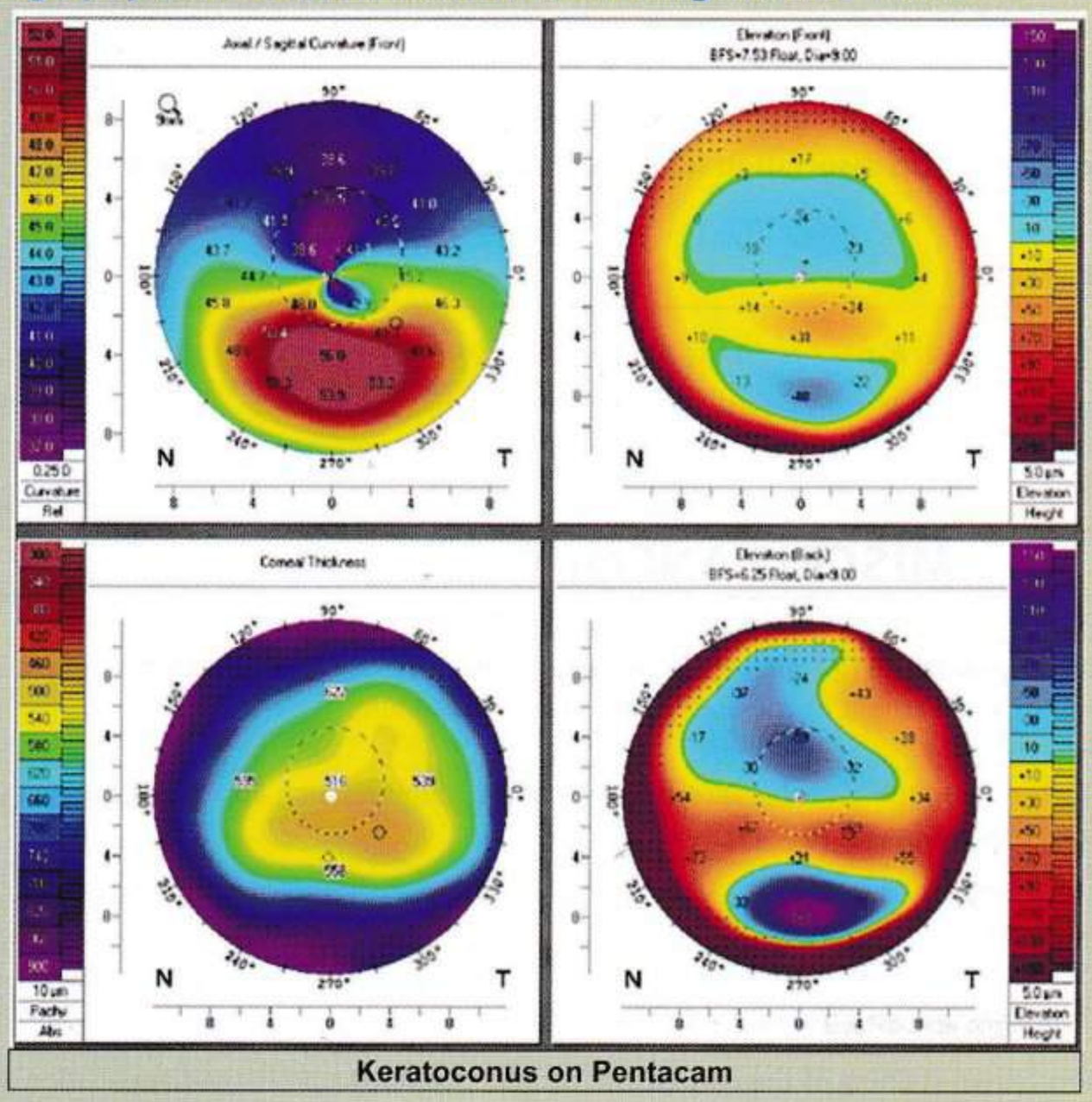
Munson sign - Keratoconus

Rizutti sign

- **Corneal topography**

EXTRA MILE

Corneal Topography is the Gold standard for screening of keratoconus

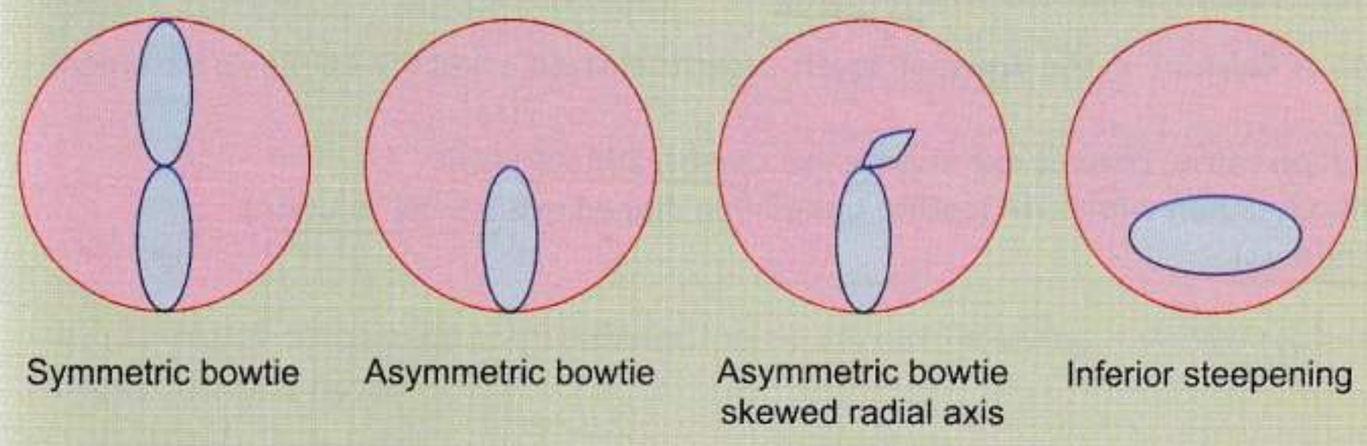


Keratoconus on Pentacam

Axial curvature map shows inferior corneal steepening

Pachymetry map shows corneal thinning in the area corresponding to steepening (warm colour – yellow)

Elevation maps show Paracentral bulge



Progression of keratoconus on topography

Topgraphic indices for diagnosis of keratoconus [RABINOWITZ CRITERIA]

- Keratometry >47.20 D
- Steepening of inferior cornea compared to superior cornea >1.2 D
- Skewing of radial axis of astigmatism by >21 degree

Treatment

- **C3R/CXR/CCC** – Corneal collagen crosslinking with Riboflavin

Dresden protocol

Anesthesize the eye

↓

remove the central 8–10 mm of corneal epithelium

↓

Apply 0.1% **Riboflavin** solution

↓

After 30 minutes – expose cornea to **UVA – 370 nm** with an irradiance of 3 $mWcm^2$

- Rigid contact lens or spectacles for correction of Myopic astigmatism
- Deep anterior lamellar keratoplasty (DALK)
- Intacs – Intracorneal ring segment implantation

Keratoglobus

- Limbus to Limbus, generalized corneal thinning with globular protrusion
- Usually present at birth, but may be acquired (in association with Ehlers Danlos syndrome Type VI)

Pellucid Marginal Degeneration

- Inferior corneal thinning disorder
- 'Crab–Claw' appearance on topography

MISCELLANEOUS

Interstitial Keratitis	Interstitial keratitis (IK) is an immune mediated inflammation of the corneal stroma without primary involvement of the epithelium and endothelium. **Causes** • Congenital syphilis – characterized by limbitis, salmon patch appearance, ghost vessels • Cogan syndrome – IK + deafness • Tuberculosis • Leprosy • Sarcoidosis • Viral infections – HSV, HZV, EBV, etc
Argyrosis	Deep-brown staining of the cornea and conjunctiva due to prolonged application of silver salts in chronic treatment of conditions like Trachoma
Band shaped Keratopathy **Band shaped keratopathy – interpalpebral calcification clear from the limbus**	• Deposition of **Calcium**^{Q} in the **Bowman layer**, superficial stroma and the epithelial basement membrane • Most common cause: Chronic eye disease like Uveitis, Still's disease • Treatment: Chelation with EDTA (cotton tipped bud dipped in a 1.5-3% solution)
Photo-ophthalmia	Keratoconjunctivitis due to exposure to UV–C rays (311 to 290 nm)
Kayser – Fleischer ring	Deposition of Copper in the peripheral part of Descemet membrane of the cornea, seen in Wilson disease
Crocodile shagreen	Asymptomatic polygonal stromal opacities separated by relatively clear spaces

Contd...

<table>
<tr><td>Arcus Senilis
 </td><td>Most common peripheral corneal degeneration.
It presents with lipid deposition in the corneal stroma in the perilimbal area.
Gray – white opacity is visible which begins superiorly and inferiorly
It has a clear space (Clear interval of VOGT)^{Q} separating it from the limbus</td></tr>
<tr><td>Vogt's white limbal girdle</td><td>Chalky white arc like opacities seen in nasal and temporal peripheral cornea</td></tr>
<tr><td>Hassall – Henle bodies</td><td>Drop like excrescences arising from Descemet's membrane
Seen in old age</td></tr>
<tr><td>Cornea plana</td><td>AD, bilateral flat cornea
Usually presents with Hypermetropia</td></tr>
<tr><td>Corneal opacities</td><td><table><tr><th></th><th>Pupillary Margin</th><th>Iris details</th><th>Depth of involvement</th></tr><tr><td>Nebular</td><td>Visible</td><td>Visible</td><td>Bowman's and superficial stroma</td></tr><tr><td>Macular</td><td>Visible</td><td>Not seen</td><td>≤1/2 stroma</td></tr><tr><td>Leucoma</td><td>Not seen</td><td>Not seen</td><td>≥1/2 stroma</td></tr></table>Nebular corneal opacity causes the maximum visual discomfort by inducing Irregular astigmatism^{Q}</td></tr>
<tr><td>Mooren's Ulcer</td><td>Superficial ulcer, at the corneal margins
Spreads circumferentially
Whitish overhanging margins are characteristic
Autoimmune etiology</td></tr>
<tr><td>Superior limbic keratoconjunctivitis</td><td>Inflammation of superior tarsal and bulbar conjunctiva
(+) Oedema of the limbal conjunctiva
(+) superior corneal pannus
More common in females with thyroid disease</td></tr>
</table>

Keratoplasty

Keratoplasty or corneal transpalantation or corneal grafting involves replacement of diseased host corneal tissue with healthy donor corneal tissue

Types

Penetrating Keartoplasty (PKP)

- **Full thickness** grafting
- **Indications** – Keratoconus, Pseudophakic bullous keratopathy (MC indication – Bullous keratopathy - involves mainly the epithelium and is mostly post surgical), corneal dystrophies
- Donor graft size kept 0.25mm than the opening of host cornea
- Ideal graft diameter is 7.5mm

Lamellar Keratoplasty

- **Partial thickness** excision of the epithelium and stroma
- Different types are
  - Deep anterior Lamellar keratoplasty (**DALK**) – corneal tissue rempoved upto the level of descemet membrane. Preferred in cases of keratoconus with acute hydrops
  - Descemet stripping endothelial keratoplasty (**DSEK**) – removal of only endothelium and descemet membrane. Indiacted for Pseudophakic bullous keratopathy

Storage Media

Short term	Intermediate	Long term
Upto 48 hours	Upto 2 weeks	Upto 35 days
4° C moist chamber	McKarey-Kauffman media Optisol GS	Cryopreservation at -70O C

Graft Rejection

It maybe divided into

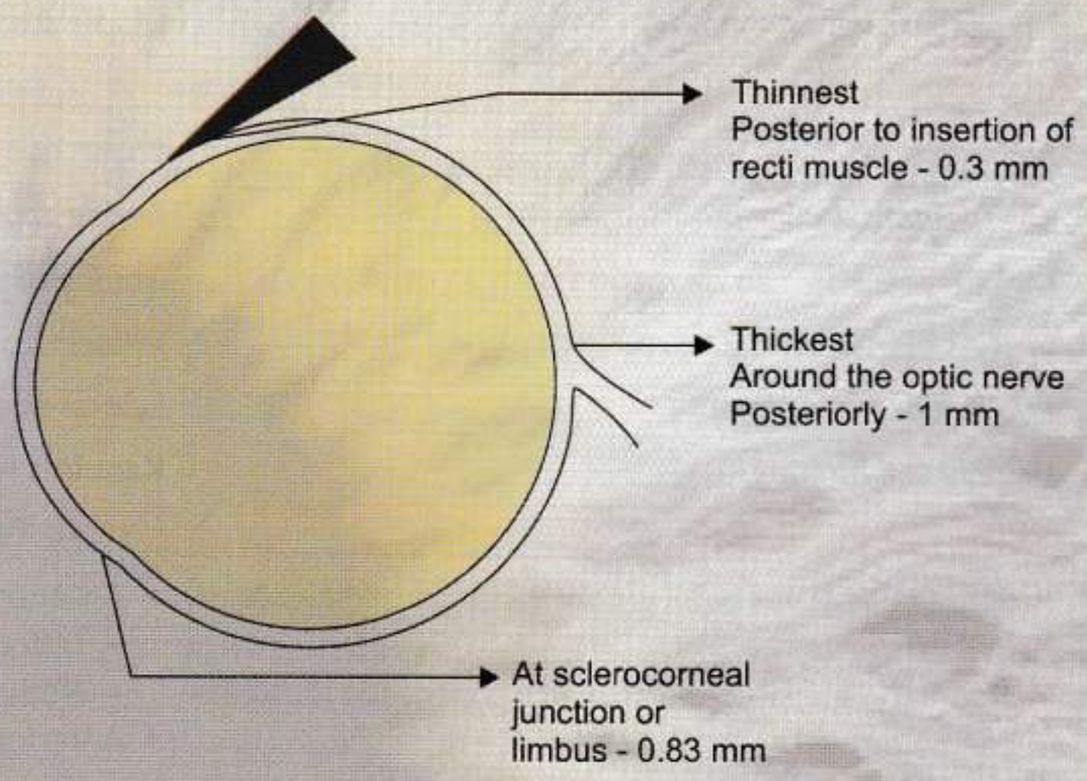
- Epithelial – seen as an elevated line of abnormal epithelium
- Subepithelial – infiltrates on the donor cornea – Krachmer spots
- **Endothelial – Most common** and most serious
  - **Khodadoust line**
  - Linear keratic precipitates and iritis

BONUS PAGE 8

SCLERA

Anatomy

It forms the posterior opaque 5/6th of the external fibrous coat of the eyeball.
Its thickness varies


Thinnest
Posterior to insertion of recti muscle - 0.3 mm
Thickest
Around the optic nerve Posteriorly - 1 mm
At sclerocorneal junction or limbus - 0.83 mm

Layers

It consists of the following 3 layers:

- **Episcleral tissue** – a thin densely vascularized layer of connective tissue overlying the sclera proper. It becomes continuous with the overlying Tenon's capsule 1-3 mm posterior to limbus.
- **Sclera proper** – avascular layer consisting of dense bundles of collagen fibres.

  Sclera has a white appearance because of the scattering of all wavelengths of light by dense irregular bundles of collagen compared to the orderly arrangement in cornea
- **Lamina Fusca** – innermost layer of sclera

Owing to the anatomical organization of the various layers, 3 vascular layers cover the anterior portion of sclera

Vascular plexuses	Locations & Vessels	Mobility of vessels	Color (when inflamed)	Clinical importance
Conjunctival plexus	Most superficial arteries are tortuous and veins are straight	Freely mobile	Bright red	Congested in conjunctivitis. Blanched with topical vasoconstrictor
Superficial episcleral plexus	Lies at the level of Tenon's capsule. Vessels are straight with radial configuration.	Mobile over deeper layers	Salmon pink	Congested in episcleritis. Blanched with topical vasoconstrictor.
Deep vascular plexus	Lies deep to the Tenon's capsule and over sclera. Vessels are arranged in criss cross pattern.	Immobile	Violaceous	Congested in scleritis. Does not blanch with topical vasoconstrictor.

Apertures

Posterior	Middle	Anterior
8 to 20 short ciliary vessels (circle of zinn) and nerves 2 long posterior ciliary arteries anterior to short ciliary	4 to 7 mm behind the equator	3 to 4 mm posterior to limbus
Optic nerve – passes through sieve like structure known as **Lamina Cribrosa**	Transmit 4 vortex veins	Transmit anterior ciliary vessels, nerves and lymphatics

Pathologies

Episcleritis	Scleritis
Usually idiopathic	Around 50% cases are associated with systemic diseases
More common in young age females	More common in older age females
Acute onset, with greater tendency to recur	Subacute or gradual onset
Normal vision	Visual acuity may be affected
Less painful Presents with irritation	Extreme deep seated pain (which often wakes up the patient from sleep)
No tenderness on palpation	Moderate to severe tenderness on palpation
Vessels	
Reddish hue	Bluish hue
Interpalpebral distribution of redness	Redness usually starts in upper temporal quadrant
Mobile vessels – can be moved with a cotton swab	Immobile vessels
Vessels blanch with 2.5% phenylephrine	Vessels do not blanch (help to differentiate from episcleritis in clinic)
Scleral edema is absent	Scleral edema is present
Usually self limiting	Requires NSAIDS or topical steroids to reduce the inflammation and symptoms
Types	
• Simple – reaches peak within 12 hours and resolves in 3-10 days • Nodular – elevated, hard, well defined, flat nodule, can be moved separately from sclera. Usually has a more prolonged course than simple episcleritis and tends to be more symptomatic	• Anterior Non Necrotizing ▪ Diffuse ▪ Nodular – associated with history of HZO. The nodules are immovable • Anterior Necrotizing ▪ With inflammation ○ Vaso-occlusive – associated with RA ○ Granulomatous – associated with Wegner's and Polyarteritis nodosa ○ Surgically induced – within 3 weeks ▪ Without inflammation **(Scleromalacia Perforans)**[Q] – occurs in women with RA. NO pain, Vision NOT affected, NO vascular congestion

IMAGE-BASED QUESTIONS

There are multiple probable questions that can be asked on a single image.

Question numbers 1 to 3 are based on Image 1.

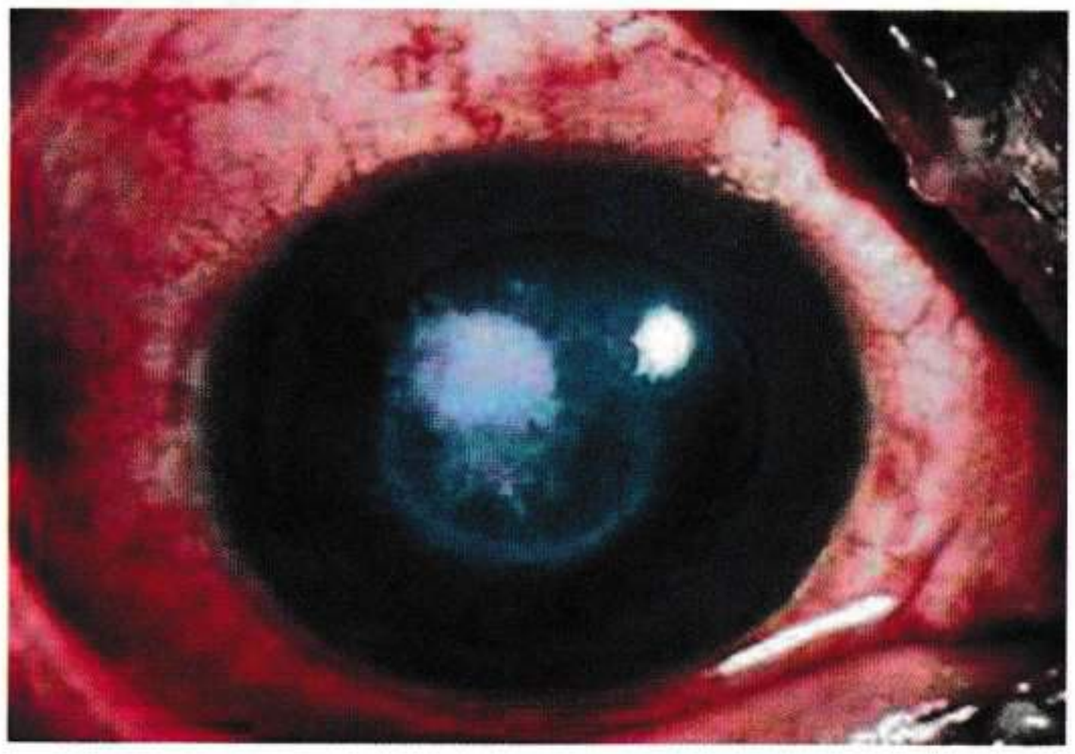


Image 1

1. **What is the most likely diagnosis in the above patient with complaints of pain, redness, lacrimation and photophobia since the past 2 days?**
   a. Fungal corneal ulcer
   b. Bacterial corneal ulcer
   c. Trachoma
   d. Granular corneal dystrophy
2. **All of the following can be seen in the image except**
   a. Hypopyon
   b. Wessely immune ring
   c. Feathery ulcer edges
   d. Hyperemia
3. **A farmer came with complaints of blurred vision, watering and pain in the eye. He gives history of injury with a stick. On examination the clinical picture given is seen. What is the best line of management in the patient?** ***(AIIMS Nov 2016)***
   a. 5% natamycin eye drops and send corneal scraping for culture
   b. Drainage of hypopyon
   c. 3.8% fortified cephazolin and send corneal scraping for culture
   d. Subconjunctival posconazole with topical steroids

Question numbers 4 to 6 are based on Image 2.

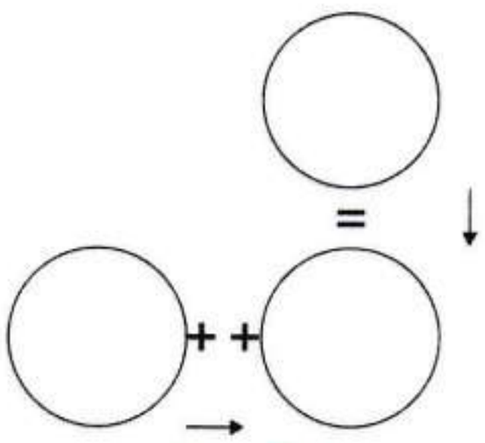
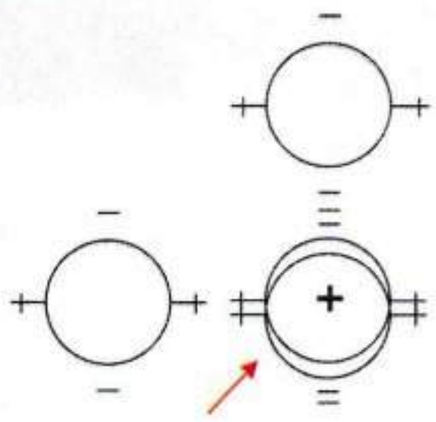


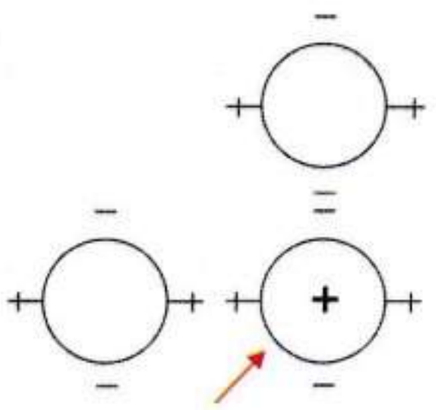
Image 2

4. **The above image is indicative of which optical investigation being done**
   a. Pachymetry
   b. Tonometry
   c. Keratometry
   d. A scan USG
5. **Which parameter in the eye is tested with the above investigation?**
   a. Corneal Thickness
   b. Size of the optic disc
   c. Corneal curvature
   d. Pupillary diameter
6. **What is the best/correct positioning of the keratometric mires?**

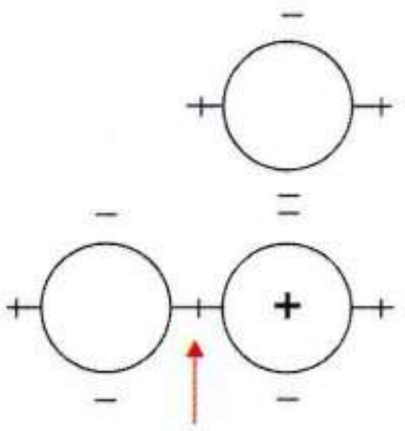
a.



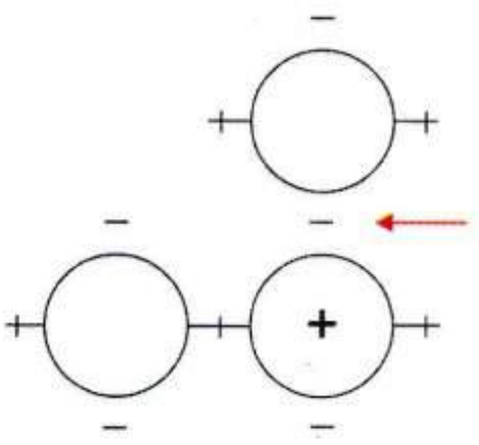
b.



c.



d.



Question numbers 7 to 10 are based on Image 3.

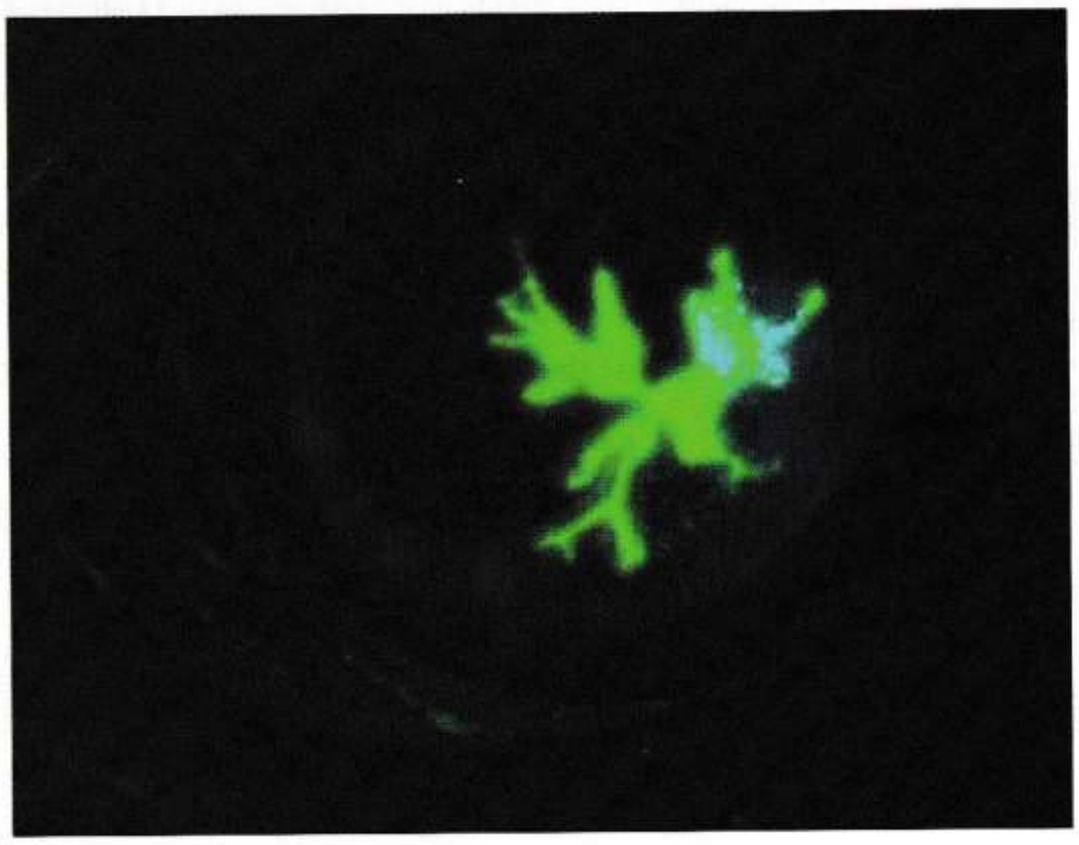


Image 3

7. **The cornea in the above image has been stained with**
   a. Alcian blue
   b. Fluorescein
   c. Rose Bengal
   d. Lissamine green

8. **A 25-year-old woman has moderate tearing pain in her left eye. She was recently placed on topical corticosteroids for suspected allergic conjunctivitis. A gram stain and Giemsa stain are negative for organisms. A fluorescein stain of the eye exhibits the above image. What is the most likely diagnosis?**
   a. Herpes zoster ophthalmicus
   b. Fungal corneal ulcer
   c. Acanthamoeba keratitis
   d. Herpes simplex keratitis

9. **All of the following can lead to the above picture except**
   a. Acanthamoeba Keratitis
   b. Herpes Simplex Keratitis
   c. Tyrosinaemia type II
   d. Soft contact lens use

10. **Which of the following is true about the above condition** *(Recent pattern 2017)*
    a. Decreased corneal sensation
    b. Increased corneal sensation
    c. Hypopyon
    d. Descematocoele formation

Question number 11 is based on Image 4.

Image 4

11. **The optical instrument shown in the image is used for evaluation of**
    a. Corneal topography
    b. Corneal curvature
    c. Retinoscopy
    d. Nuclear sclerosis

Question number 12 is based on Image 5.

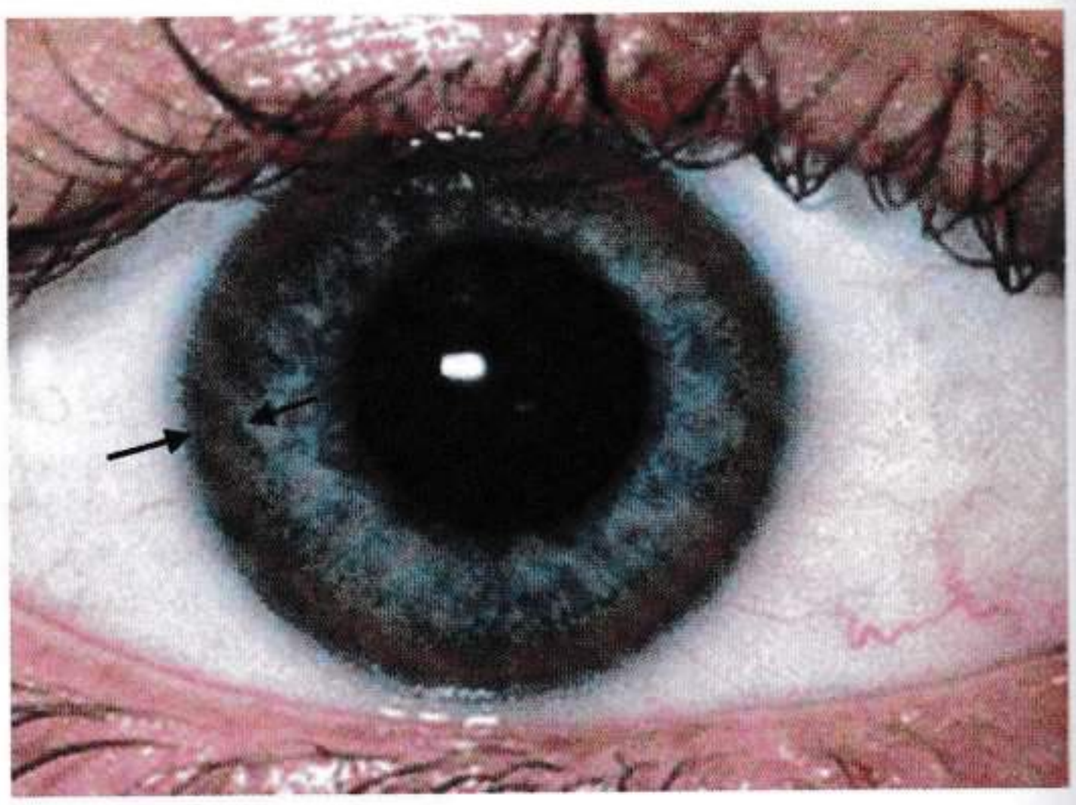


Image 5

12. **Patient with history of hepatic dysfunction. On ocular examination, the image given below is seen. Which of the following investigations should be done to confirm the diagnosis?** *(Recent pattern 2017)*
    a. Cornel scraping
    b. Serum Ceruloplasmin
    c. Serum calcium
    d. Genetic testing

Question number 13 is based on Image 6.

Image 6

13. **The patient seen above in the image is likely to develop which of the following ocular complication?**
    a. Trichiasis
    b. Spastic ectropion
    c. Nummular keratitis
    d. Dendritic keratitis

Question number 14 is based on Image 7.

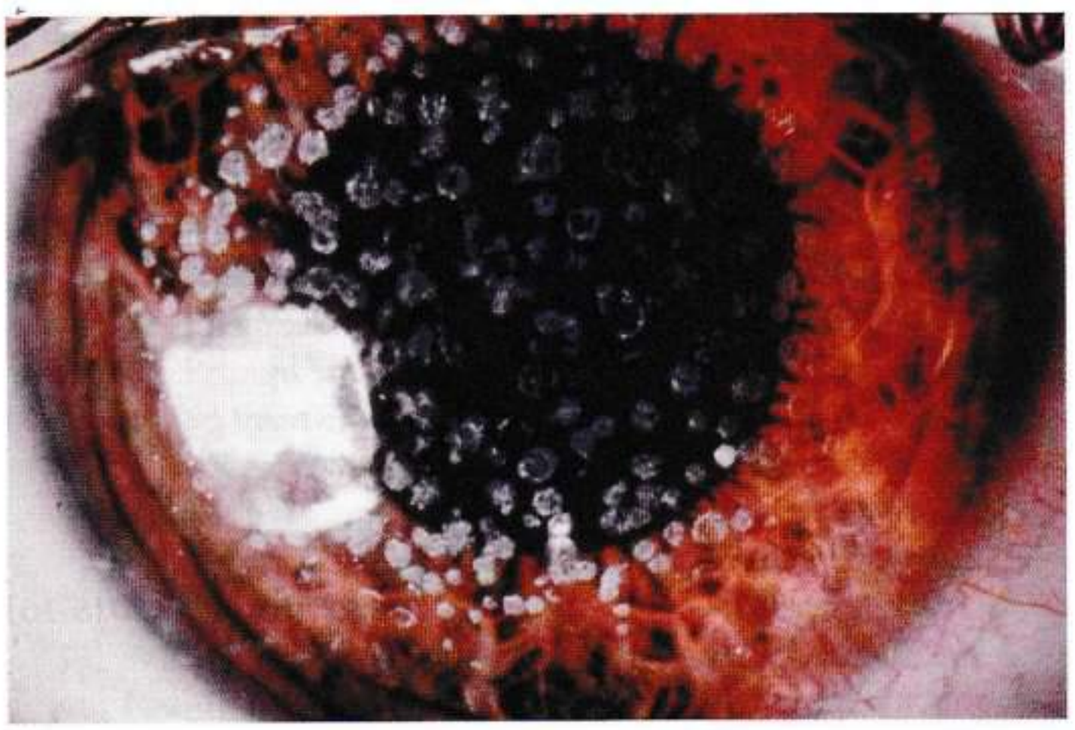


Image 7

14. **The ocular condition seen in the image can be stained with which of the following**
    a. Masson trichrome stain
    b. Congo red stain
    c. Colloidal iron
    d. Prussian blue
15. **The above condition affects which layer of cornea?**
    a. Epithelium
    b. Bowman's layer
    c. Stroma
    d. Endothelium

MULTIPLE CHOICE QUESTIONS

Anatomy and Physiology

16. **Which is the innermost layer of corneal epithelium?** *(Recent pattern 2014)*
    a. Keratinized squamous cells
    b. Flattened squamous cells
    c. Umberella shaped cells
    d. Columnar cells
17. **Enlarged corneal nerves may be seen in all of the following except** *(All India 2005)*
    a. Keratoconus
    b. Herpes simplex keratitis
    c. Leprosy
    d. Neurofibromatosis
18. **Transparency of cornea is mainly due to which layer?** *(Recent pattern Nov/Dec 2016)*
    a. Endothelium
    b. Descemet's membrane
    c. Bowman's membrane
    d. None of these
19. **Normal corneal endothelial count in a young adult is** *(Recent pattern Nov/Dec 2016)*
    a. $500/mm^2$
    b. $2500/mm^2$
    c. $4500/mm^2$
    d. $6500/mm^2$
20. **All are true regarding cornea except:** *(PGI May 2015)*
    a. Endothelium help in maintaining dehydrated state
    b. Oxygen is mostly derived by epithelium directly from the air through tear film
    c. Glucose supply for corneal metabolism is mainly derived from the aqueous
    d. Corneal thickness is more at center than periphery
    e. Richly vascular
21. **True about cornea:** *(PGI Nov 2010)*
    a. Power is 43D
    b. Majority of refraction occur at air-tear interface
    c. With the rule astigmatism is present because vertical meridian more steep than horizontal meridian
    d. Spherical structure
    e. Refractive index 1.334
22. **In hypoxic injury, cornea becomes edematous because of accumulation of:** *(AIIMS Nov 2014)*
    a. Carbon dioxide
    b. Lactate
    c. Pyruvate
    c. Glycogen
23. **Afferent component of corneal reflex is mediated by** *(All India 2006)*
    a. Vagus nerve
    b. Facial nerve
    c. Trigeminal nerve
    d. Glossopharyngeal nerve

Corneal Investigations

24. **Fluorescein dye is used to stain** *(Recent pattern Dec 2016)*
    a. Areas of denuded epithelium
    b. Diseased and devitalized cells
    c. Mucus
    d. All of the above
25. **Corneal sensation is tested by which device?** *(Recent pattern Nov/Dec 2016)*
    a. Pachymeter
    b. Keratometer
    c. Aesthesiometer
    d. Vernier calliper

Most Recent Questions of 2019-2017 are given at the end

26. Corneal thickness is measured by all except: *(Recent pattern 2014)*

a. Pachymetry
b. Optical coherence tomography
c. Confocal microscopy
d. Placido keratoscopic disc

27. Placido disc is used for diagnosis of *(Recent pattern Nov/Dec 2016)*

a. Uveitis
b. Keratoconus
c. Retinoblastoma
d. Retinal detachment

28. Corneal endothelial cell counting is done by *(Recent pattern 2013)*

a. Tachymetry
b. Pachymetry
c. Specular microscope
d. Perimetry

29. Corneal sensation is measured by? *(Recent pattern 2015-16)*

a. Aesthesiometer
b. Pachymeter
c. Keratometer
d. Tonometer

Keratitis

30. Which of the following is true about Herpes Simplex Keratitis?

a. Topical Steroids are not contraindicated in Disciform keratitis
b. Metaherpetic keratitis is due to paralysis of the facial nerve
c. Oral antiviral drugs are not advised in cases of Necrotizing stromal keratitis
d. Debridement of the ulcer edge with a sterile cellulose sponge 2 mm beyond the edge of the ulcer is done in cases of geographic ulcer

31. Drug of choice for Nummular keratitis

a. Acyclovir 3% ointment
b. Topical Steroids
c. Intravenous antivirals
d. Keratoplasty

32. A 60-year-old man complains of left eye pain and photophobia. On examination there is an erythematous rash of the periorbital skin and forehead on the left side. You also note erythema and a small vesicle on the tip of the patient's nose. His ipsilateral conjunctiva is injected and after staining the affected eye with fluorescein, Wood's lamp examination reveals corneal uptake in a fine branching pattern. What is the most appropriate therapy for this patient? *(AIIMS Nov 2015)*

a. Oral acyclovir 800 mg three times a day for 7-10 days
b. Oral valacyclovir 500 mg three times a day for 7 days
c. Oral famciclovir 500 mg three times a day for 7 days
d. Topical acyclovir, 5 times a day until resolution of ocular symptoms

33. Which of the following is the drug of choice for treatment of corneal ulcers caused by filamentous fungi? *(All India 2006, Recent pattern Dec 2016)*

a. Itraconazole
b. Natamycin
c. Nystatin
d. Flucomazole

34. Which of the following statement is true regarding acanthamoeba keratitis? *(All India 2005)*

a. For the isolation of the causative agent, corneal scraping should be cultured on a nutrient agar plate
b. The causative agent, acanthamoeba is a helminth whose normal habital is soil.
c. Keratitis due to acanthamoeba is not seen in the immuno-compromised host
d. Acanthamoeba does not depend upon a human host for the completion of its life-cycle

35. Contact lens wear is proven to have deleterious effects on the corneal physiology. Which of the following statements is incorrect in connection with contact lens wear? *(All India 2005)*

a. The level of glucose availability in the corneal epithelium is reduced
b. There is a reduction in hemidesmosome density
c. There is increased production of CO_2 in the epithelium
d. There is a reduction in glucose utilization by corneal epithelium

36. Which organism does not invade intact cornea? *(Recent pattern 2014)*

a. Pseudomonas
b. N. meningitidis
c. N. gonorrhoea
d. C. diphtherias

37. Which organism infection is virulent and may cause corneal ulcer perforation within 48hrs? *(AIIMS May 2014)*

a. Pseudomonas
b. Aspergillus
c. Herpes simplex
d. Staphylococci

38. Which of the following is not given as eye drops in corneal ulcer? *(AIIMS Nov 2012)*

a. Flurometholone
b. Olopatadine
c. Methylcellulose
d. Chloramphenicol

39. In Herpes zoster Keratitis all occurs except

a. Pseudodendritic keratitis *(AIIMS Nov 2012)*
b. Anterior stromal keratitis
c. Sclerokeratitis
d. Endothelitis

40. A regular contact lens user presents with complaints of severe pain, photophobia and blurring of vision for more than two weeks not responding to standard treatment. On examination, a paracentral ring shaped lesion with stromal infiltrates and overlying epithelial defects is observed in the affected eye. Which of the following is the most likely diagnosis? *(All India 2012)*

a. Bacterial keratitis
b. Acanthomoeba keratitis
c. Viral keratitis
d. Fungal keratitis

41. A 30 years old male from a rural background presents to the ophthalmology clinic with history of difficulty in vision for 10 days. He gives history of vegetative material falling into left eye about 15 days back. On examination an ulcerative lesion in the cornea with feathery margins and creamy exudates is seen. Few satellite lesions were also noted. The most likely diagnosis etiologic agent is:

a. Corynebacterium diphtheriae
b. Fusarium species
c. Acanthomoeba species
d. Streptococcus pneumonia

Most Recent Questions of 2019-2017 are given at the end

42. **A person with prolonged usage of contact lenses presented with irritation of left eye. After examination a diagnosis of keratitis was made and corneal scrapings revealed growth of pseudomonas aeruginosa. The bacteria were observed to be multidrug resistant. Which of the following best explains the mechanism of antimicrobial resistance in these isolated pseudomonas aeroginosa strains?**
   a. Ability to transfer resistance genes from adjacent commensal flora
   b. Improper contact lens hygiene
   c. Frequent and injudicious use of topical antibiotics
   d. Ability of Pseudomonas to produce biofilms

43. **Which of the following is/are not the feature(s) of corneal ulcer due to herpes virus:** *(PGI May 2016)*
   a. Rose Bengal staining of margin of ulcer
   b. Decreased corneal sensitivity
   c. Fluorescein staining of floor of the ulcer
   d. Ring infiltration

44. **Which of the following is/are caused by bacterial infection:**
   a. Phlyctenular conjunctivitis *(PGI May 2013)*
   b. Marginal keratitis
   c. Mooren ulcer
   d. Vogt-Koyanagi -Harada syndrome
   e. Hypopyon ulcer

45. **Interstitial keratitis is seen in all except:**
   a. Syphilis b. Acanthamoeba
   c. Chlamydia trachomatis d. HSV
   e. HZV

46. **True about Acanthamoebic keratitis:** *(PGI Nov 2016)*
   a. More in those wearing rigid gas permeable than soft contact lens users
   b. Can occur as opportunistic infection in patients with herpetic keratitis
   c. Can be cultured on non-nutrient agar enriched with E. coli
   d. Painful condition
   e. Radial keratoneuritis may occur

47. **A 33 year old man presents to AIIMS ophthalmology OPD with pain and watering of eyes. On examination there was a 3X2 mm greyish white corneal ulcer with indistinct elevated margins. The lesion is surrounded by feathery finger like infiltration into the adjacent corneal stroma. Minimal hypopyon is also observed. Based on the information provided the microbiological investigation should be directed against** *(AIIMS May 2016)*
   a. Aspergillus spp.
   b. Pseudomonas spp.
   c. Herpes simpex virus
   d. Acanthamoeba spp

48. **Which of the following organism produce corneal ulcer resembling fungal ulcers** *(AIIMS May 2016)*
   a. Nocardia asteroids b. Klebsiella species
   c. Mycobateria d. Chlamydia

49. **Which of the following is not a feature of fungal corneal ulcer?** *(AIIMS Nov 2014)*
   a. Fixed hypopyon
   b. Ulcer with sloughing margins
   c. Symptoms are more pronounced than signs
   d. Fungal hyphae are seen on KOH mount

Corneal Dystrophies

50. **Which one of the following stromal dystrophy is a recessive condition?** *(All India 2006)*
   a. Lattice dystrophy b. Granular dystrophy
   c. Macular dystrophy d. Fleck dystrophy

51. **Corneal dystrophies are usually:** *(AIIMS May 2012)*
   a. Primarily unilateral
   b. Primarily bilateral
   c. Primarily unilateral without systemic disease
   d. Primarily bilateral with systemic disease

52. **Which of the following is the least common corneal dystrophy?** *(All India 2010)*
   a. Macular Dystrophy b. Lattice type I
   c. Lattice type III d. Granular Corneal Dystrophy

53. **Which of the following stain is used for diagnosis of Granular dystrophy of cornea?** *(AIIMS May 2015)*
   a. Colloidal iron b. Congo red
   c. PAS d. Masson trichrome

Miscellaneous

54. **Sarcoidosis is associated with:** *(All India 2008)*
   a. Band keratopathy b. Systemic amylodosis
   c. Angioid streaks d. Cataracta nigra

55. **Weakest portion of sclera is** *(PGI May 2011)*
   a. Limbus b. Quator
   c. Anterior to attachment of superior rectus
   d. Front of rectus insertion
   e. Behind rectus insertion

56. **Stroma of cornea develops from** *(Recent pattern Nov/Dec 2016)*
   a. Neuroectoderm b. Mesoderm
   c. Surface ectoderm d. Neural crest

57. **Which of the following contains long spaced collagen?** *(AIIMS May 2013)*
   a. Diaphragm b. Cornea
   c. Basement membrane d. Tympanic membrane

58. **Band shaped keratopathy occurs due to deposition of** *(AIIMS Nov 2013)*
   a. Amyloid b. Iron
   c. Calcium d. Melanin

59. **The combination of fixed dilated pupil with iris atrophy and secondary glaucoma following penetrating keratoplasty is known as?** *(AIIMS Nov 2012)*
   a. Benedikt's syndrome
   b. Posner-Schlossman syndrome
   c. Urrets-Zavalia syndrome
   d. Kaufman syndrome

60. **Percentage of endothelial loss in Descemets stripping automated endothelial keratoplasty** *(AIIMS Nov 2011)*
   a. 5% b. 10–20%
   c. 30–40% d. 50–60%

61. **Which of the following suggests episcleritis while differentiating it with scleritis?** *(Recent pattern 2013-14)*
   a. Severe pain
   b. Tenderness
   c. Congested vessels cannot be moved with cotton bud
   d. Blanching of vessels with 10% phenylephrine

Most Recent Questions of 2019-2017 are given at the end

62. **Which of the following statements regarding corneal transplantation is true?** *(All India 2010)*
   a. Whole eye needs to be preserved in tissue culture
   b. Donor not accepted if age > 60 years
   c. Specular microscopy analysis is used to assess endothelial cell count
   d. HLA matching is mandatory

63. **Cloudy cornea is/are seen in which of the following** *(PGI May 2016)*
   a. Klinefelter syndrome b. Turner syndrome
   c. Megalocornea d. Mucopolysaccharidosis

64. **True about Kayser-Fleischer ring:** *(PGI Nov 2015)*
   a. Deposition of copper
   b. Deposition of iron
   c. Found in Wilson disease
   d. Deposition under Descemet's membrane of the cornea

65. **True about Arcus senilis:** *(PGI Nov 2012)*
   a. Fatty infiltration
   b. Axial corneal degeneration
   c. Deposition occur in stroma of peripheral cornea
   d. Amyloid deposit
   e. Involve limbus

66. **Keratoconus is/are associated with:** *(PGI Nov 2012)*
   a. Marfan syndrome b. Ehler-Danlos syndrome
   c. Usher syndrome d. Down syndrome

67. **A patient on amiodarone is diagnosed to have cornea verticillata. What should be management:** *(PGI Nov 2010)*
   a. Stop the drug b. Penetrating keratoplasty
   c. Lamellar keratoplasty d. Observation
   e. Steroids

68. **Treatment of photophthalmia includes:** *(PGI May 2010)*
   a. Irrigation with saline water
   b. Padding & Bandaging
   c. Cold compresses
   d. Lubricant eyedrop
   e. Analgesics

69. **True about Nodular episcleritis:** *(PGI Nov 2016)*
   a. Can be associated with SLE
   b. Take longer time to resolve than diffuse variety
   c. More symptomatic than diffuse type
   d. Painless
   e. Elevated hard nodule

70. **Not true about Blue sclera:** *(PGI May 2017)*
   a. Seen in Osteogenesis imperfecta
   b. Does not occur in Ehlers-Danlos syndrome
   c. Blue color is produced by underlying uveal pigment
   d. Seen in Marfan's syndrome
   e. Sclera is thin

71. **True about ferritin line in eye** *(PGI Nov 2016)*
   a. Ferry's Line-corneal epithelial iron line at the edge of filtering blebs
   b. Stockers Line-Corneal epithelial iron line at the edge of pterygium
   c. Hudson-Stahli line- visible all around the base of cone in Keratoconus
   d. Fleischer's ring: Horizona corneal epithelial iron line at the inferior one-third of cornea due to aging
   e. Coat's white ring- A form of iron deposit at the level of Bowman's layer of cornea

72. **Which of the following is not an absolute contraindication for corneal transplantation?** *(AIIMS Nov 2014)*
   a. TB meningitis b. Rabies
   c. Death due to unknown cause
   d. SSPE

73. **Which is not a differential diagnosis of blue sclera?**
   a. Osteogenesis imperfecta
   b. Ehlers-Danlos syndrome
   c. Neurofibromatosis d. Marfan's syndrome

74. **Which among the following is the characteristic feature of scleromalacia perforans?**
   a. Pain b. Marked loss of vision
   c. Lack of inflammation d. Typically seen in males

75. **All of the following are true about keratoglobus except**
   a. Globular ectasia b. Generalized corneal thinning
   c. Prone to rupture d. Increased corneal diameter

76. **Tattooing of cornea is identified with**
   a. Au b. $CuSO_4$
   c. $CaCl_2$ d. NaCl

Most Recent Questions of 2019-2017

77. **Corneal ulcer is defined as:** *(PGI May 2017)*
   a. Erosion of epithelium only
   b. Erosion of endothelium only
   c. Erosion of epithelium with underlying inflammation
   d. Loss of endothelium with loss of corneal sensation

78. **Which of the following signs may be seen in a case of Fungal corneal ulcer?** *(PGI Nov 2017)*
   a. Satellite lesions b. Wesseley immune ring
   c. Mobile hypopyon d. Depressed ulcer edges
   e. Feathery margins

79. **Hypopyon is seen in which of the following diseases** *(PGI May 2018)*
   a. Retinitis pigmentosa b. Behçet's disease
   c. Best's dystrophy d. Fungal corneal ulcer

80. **Which of the following drugs is used as an adjuvant therapy for treatment of fungal corneal ulcers?** *(AIIMS May 2018)*
   a. Atropine eye drops b. Pilocarpine eye drops
   c. Dexamethasone eye drops
   d. Lidocaine

81. **Patient presented to ophthalmology OPD with glaucoma and bulging of cornea. What is the diagnosis?** *(AIIMS Nov 2017)*
   a. Granular dystrophy b. Staphyloma
   c. Keratomalacia d. Keratoconus

82. **Which of the following drugs is used as an adjuvant therapy for treatment of fungal corneal ulcers?** *(AIIMS May 2018)*
   a. Atropine eye drops b. Pilocarpine eye drops
   c. Dexamethasone eye drops
   d. Lidocaine

83. **A patient with pain and watering since 72 hrs. On examination a corneal ulcer measuring 4 mm × 3 mm with feathery margin, rolled out edges and minimal hypopyon is seen. What is the likely cause?** *(AIIMS Nov 2018)*
   a. Aspergillus b. Bacterial
   c. Acanthamoeba d. Herpes Simplex Virus

84. **In Keratoconus, the thinning of cornea starts from** *(JIPMER Dec 2018)*
   a. Centre b. Periphery
   c. Mid-periphery d. Limbus

Most Recent Questions of 2019-2017 are given at the end

ANSWERS TO IMAGE-BASED QUESTIONS

1. Ans. (a) Fungal corneal ulcer

Ref: Parson's 20/e, p. 192

2. Ans. (a) Hypopyon

Ref: Parson's 20/e, p. 193

Hypopyon is Pus in the Anterior Chamber, and is seen inferiorly. Characteristically it is Asterile and Immobile.

Wessely immune ring and satellite lesions can be seen along with redness/Hyperemia of the conjunctiva.

3. Ans. (a) 5% natamycin eye drops and send corneal scraping for culture

The mainstay of treatment is the use of antifungal drops, but only a polyene, natamycin 5%, is FDA approved. It is used for Filamentous fungi, MC cause being Aspergillus.

Amphotericin B, a polyene, in a 0.15% dilution in sterile water, is still used today alone and in combination with natamycin as initial therapy or Candida infection.

Voriconazole, a triazole antifungal agent, can be used either topically at 1% dilution, orally at 400 mg twice a day.

Oral posaconazole, a new generation triazole has been successful eradicating deep infections of resistant Fusarium.

Subconjuctival antifungals are not generally used because the produce severe pain and some might even induce tissue necrosis.

Steroids are contraindicated.

4. Ans. (c) Keratometry

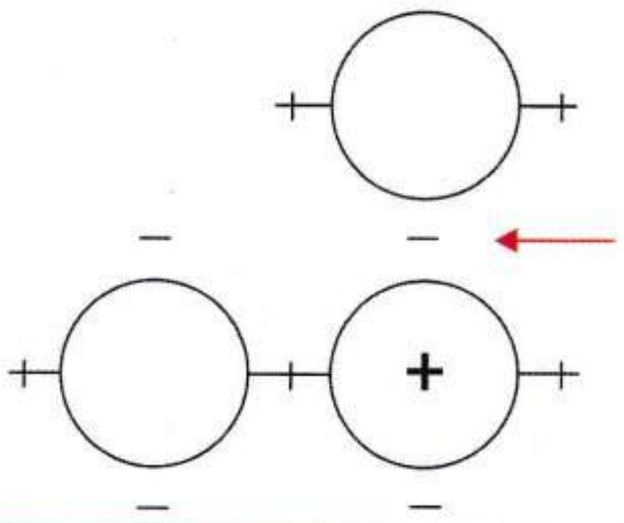
Ref: Theroy & Practice of Optics & Reflection, A.K. Khurana 2/e, p. 164

Keratometric mires can be seen in the image.

5. Ans. (c) Corneal curvature

Option A – Corneal thickness measurement is Pachmetry.
Option b – Optic disc diameter is calculated on 90D fundus examination (1DD=1.5 mm)
Option D – Pupil is an aperture and its diameter depends upon the dilatation, measured by the slit size on Slit lamp examination.
Option c – keratometry is used to measure the corneal curvature and calculate the corneal refractive power.

6. Ans. (d)



The correct positioning is with the Minus sign overlapping between the two vertical mires and the plus sign overlapping between the two horizontal mires.

7. Ans. (b) Fluorescein dye

8. Ans. (d) Herpes Simplex Dendritic Keratitis

In the image a dendritic ulcer can be seen with a branching pattern. Steroids are contraindicated for the treatment as they lead to progression.

9. Ans. (d) Soft contact lens use

Option a – Early misdiagnosis as herpes simplex keratitis is relatively common, due to Epithelial PSEUDODENDRITES or dendritiform lesions.
Option b – HSV epithelial keratitis, associated with active virus replication progresses from Superficial Punctate Keratitis to Dendritic ulcer to Geographic ulcer.

The ends of the Dendritic ulcer have characteristic terminal buds.
Option c – Pseudodendritic keratitis has been described, but the corneal lesions do not/poorly stain with fluorescein. Presents usually with skin lesions in pediatric population.
Option d – extended wear soft contact lenses, healing corneal abrasion, epithelial rejection in a corneal graft and toxic keratopathy can also lead to Dendritic ulceration.

10. Ans. (a) Decreased corneal sensation

Ref: Parson's 20/e, p. 194, Khurana 6/e, p. 108

11. Ans. (a) Corneal topography

Ref: Khurana optics 2/e, p. 169

Corneal topography refers to the study of the shape of the corneal surface. It is evalauated with the help of a Keratoscope

Placido Disc Topography – consists of equally spaced alternating black and white rings with a hole in the centre to observe (as seen in the image given in the question)

The following results may be seen on examination

- Areas where the mires appear closer together – steeper corneal curvature
- Areas where mires are more widely spaced – flatter corneal curvature
- Distinct, well formed mires – regular and smooth surface

12. Ans. (b) Serum Ceruloplasmin

Ref: Kanski 7/e, p. 230-231, Harrison's 17/e, p. 1981,2450

Keratopathy in Wilson's disease in present in all patients (>99% patients with neuropsychiatric symptoms).

It presents as a brownish ring in the peripheral part of Descemet membrane – best detected on Gonioscopy

Correlate Box

- Wilson disease is Autosomal Recessive – due to mutations on ATP7B gene which impairs biliary copper excretion and leads to hepatic copper acculmulation
- Presents with Cirrhosis of liver, movement disorders (dystonia, incoordination and tremor), behavioral disturbances, Kayser-fleischer ring, sunflower cataract, spontaneous abortions, amenorrhoea
- Diagnosis
  - Gold standard – Liver biopsy
  - Serum ceruloplasmin – not used for definitive diagnosis – low in 90% patients
  - Urine copper – increased
  - Liver copper – increased
- Prognosis – Nazer index

13. Ans. (c) Nummular keratitis

Ref: Parson's 22/e, p. 208

Herpes Zoster Ophthalmicus – skin in the area supplied by ophthalmic branch of trigeminal nerve is involved with zoster virus causing vesicles. Ocular complications arise as the eruptions are subsiding. Nummular keratitis is seen in such cases.

14. Ans. (a) Masson trichrome stain

Ref: Parson's 22/e, p. 213; Kanski 7/e, p. 219-221

Small, white, sharply demarcated crumb like deposits are seen with clear intervening stroma and a clear corneal periphery also – these are features suggestive of Granular corneal dystrophy, which shows hyaline deposits and thus can be stained by Masson Trichrome stain.

15. Ans. (c) Stroma

ANSWERS TO MULTIPLE CHOICE QUESTIONS

16. Ans. (d) Columnar cells

Ref: Yanoff 4/e, p. 163-164

17. Ans. (b) Herpes simplex keratitis

Ref: Causes of Enlarged Corneal Nerves International Ophthalmology Clinics 4 (1): 12-23; Winter 2001 (Lippincott Williams & Wilkins) by kim, stella K. M.D.: Dohlman, Claes H. M.D., Ph.D

18. Ans. (a) Endothelium

Ref. Khurana 4/e, p. 90

19. Ans. (b) 2500/mm²

Ref. Parson's 21/e, p. 120

- The cell density of endothelium is around 2800 cells/mm² (2400–3000 cells/mm²) in young adults, which decreases with the advancing age.

20. Ans. (d) Corn….; (e) Rich….

Ref: Khurana 6/e, p. 95-97; Parson's 22/e, p. 191-93; Cornea by Krachmer 2/e, p. 3, 729-31

21. Ans. (a) Power..; (b) Major..; (c) With..

Ref: Parson's 20/e, p. 181-82; Cornea by Krachmer 2/e, p. 3,729-31; American Academy of Ophthalmologist: Cornea, Section 8, 2009-2010 p. 6

- "The *air-tear film interface* provides the *major optical power of the eye*[Q].
- The aspheric shape of the cornea generally reduces spherical aberration, minimizing refractive error fluctuations as the pupil changes size"

22. Ans. (b) Lactate

Ref: Parson's 20/e, p. 184

Read explanation to Q31.

23. Ans. (c) Trigeminal nerve

Ref: Fuller Neurological examination made easy 3/e, p. 102

The afferent component of corneal reflex is mediated through the ophthalmic branch of the trigeminal nerve (Vth nerve).

The efferent component is mediated through the facial nerve (VIIth nerve).

Following corneal stimulation:

- Failure of either side of face to contract = Nasociliary nerve lesion
- Failure of only one side to contract = Facial nerve lesion.

24. Ans. (a) Areas of denuded epithelium

Ref: Cornea E-book by Mark J Mannis p. 116

Option a – Fluorescein staining is the most useful to delineate areas denuded of epithelium (abrasions, erosions, ulcer). Stain a brilliant green, when examined under cobalt blue light.
Option b – Rose Bengal stains diseased and devitalized cells Red.
Option c – Alcian blue stains the mucus. Helpful in diagnosing tear film abnormalities.

25. Ans. (c) Aesthesiometer

Ref: Khurana 4/e, p. 472

26. Ans. (d) Placido keratoscopic disc

Ref: Textbook of Ophthalmology edited by Sunita Agarwal, Athiya Agarwal, Lucio Buratto, David J. Apple, Jorge L. Alio Volume 1/980-987

Measurement of corneal thickness can be done by:

- **Specular microscopy:** Objective/indirect method as it is originally for endothelial cell count
- **Optical pachymetry**
- **Ultrasonic pachymetry:** Currently the preferred method because of ease of use, precision, portability, and ability to measure corneal thickness eccentrically
- Pachymetry using ORBSCAN Topography system
- Pachymetry using laser doppler interferometry (LDI)
- Anterior segment optical coherence tomography (ASOCT)
- Confocal microscopy: Real time observation of living cornea. Can identify cellular structure of cornea. Thickness of each layer can be measured. **Advantage over specular microscopy is that it can visualize endothelium in presence of corneal edema.**

27. Ans. (b) Keratoconus

Ref. Yanoff 4/e, p. 168

28. Ans. (c) Specular microscope

Ref. Yanoff 3/e, p. 83

29. Ans. (a) Aesthesiometer

Ref: Parson's 21/e, p. 121

30. Ans. (a) Topical Steroids are not contraindicated in Disciform keratitis

Ref: Kanski 7/e, p. 182-185

Option a – Initial treatment in Disciform keratitis/Endothelitis is with topical steroids and antiviral.

Topical steroids are contraindicated in Epithelial keratitis (in Dendritic ulcer - promotes progressive enlargement to Geographic ulcer)
Option b – Metaherpetic keratitis/Neurotrophic ulceration is caused by failure of re-epitheliazation resulting from corneal anesthesia, thus, caused by 5th nerve paralysis.
Option c – Oral antiviral supplementation at high dose is beneficial.
Option d – Can be done in Dendritic ulcer but not geographic ulcers.

31. Ans. (b) Topical Steroids

Ref: Kanski 7/e, p. 189

Nummular keratitis is characterized by fine granular **subepithelial** deposits, surrounded by a halo of stromal haze. **Develops 10 days after onset of rash.**
Only Topical steroids are given for treatment.

32. Ans. (c) Oral famciclovir... > (d) Topical acyclovir...

Ref: Yanoff 4/e, p. 182

This patient has herpes zoster ophthalmicus, as Dendritic ulcer with Shingles.

The mainstay of treatment for herpes zoster ophthalmicus are oral antiviral agents. **Oral acyclovir, 800 mg 5 times a day for 7-10** days.

Other antiviral agents which have been shown to be equally safe and effective for herpes zoster ophthalmicus are valacyclovir and famciclovir, whose more favorable pharmacokinetic profiles and simpler dosing regimens make them the **current preferred** antiviral over acyclovir. Valacyclovir is given at 1000 mg 3 times a day for 7 days or Famciclovir, is given at 500 mg 3 times a day for 7 days.

33. Ans. (b) Natamycin

Ref: Parson's 19/e, p. 160

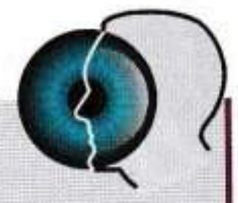
Refer text

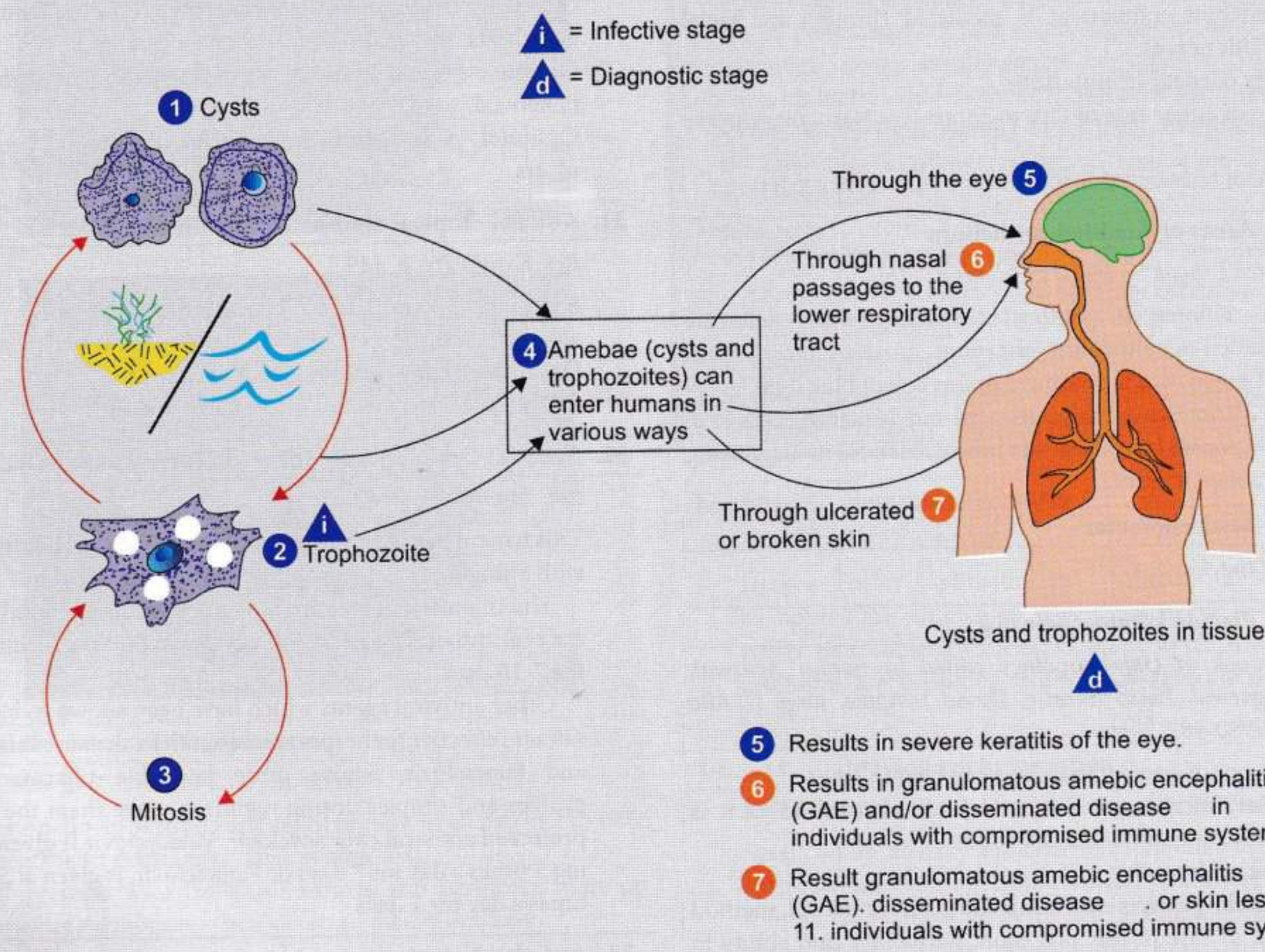
34. Ans. (d) Acanthamoeba does not depend upon a human host for the completion of its life-cycle

Ref: Kanski 7/e, p. 194, Khurana 3/e, p. 128

- Acanthoemeba do no require a human host to complete their life cycle. They have only two stages, in their life cycle, cysts and trophozoites. The **trophozoites replicate by mitosis**. The trophozoites are the **infective forms** and are believed to gain entry into the body through the lower respiratory tract. Ulcerated or broken skin and invade the central nervous system by hematogenous dissemination
- Acanthoemoeba are **free living amoeba (protozoa)** found in the soil, fresh water, well water, sea water, sewage and air
- Acanthoemoeba infections are more common in chronically ill immunocompromised or other debilitated patients
- For the isolation of causative agent corneal scraping should be cultured on non nutrient agar.

Correlate Box




i = Infective stage
d = Diagnostic stage
1 Cysts
2 i Trophozoite
3 Mitosis
4 Amebae (cysts and trophozoites) can enter humans in various ways
Through the eye 5
Through nasal 6 passages to the lower respiratory tract
Through ulcerated or broken skin 7
Cysts and trophozoites in tissue
d
5 Results in severe keratitis of the eye.
6 Results in granulomatous amebic encephalitis (GAE) and/or disseminated disease in individuals with compromised immune systems.
7 Result granulomatous amebic encephalitis . (GAE). disseminated disease . or skin lesions 11. individuals with compromised immune systems.

35. Ans. (a) The level of glucose availability in the corneal epithelium is reduced

Ref: 'The physiological causes of contact lens complications' continuing education, Judith Morris MSC, FC option

- Glucose the main nutrient for corneal metabolic activity is obtained primarily from the aqueous humour and not from the air

Contact lens affect on Corneal physiology

- Corneal hypoxia
- Decreased PaO_2 (as oxygen diffuses into cornea through tear film) → increased $PaCO_2$ and lactate production (due to anaerobic metabolism) → osmotic changes lead to stromal edema and an acidic shift in pH
- Decrease in corneal sensitivity
- Decreased tear volume – hyperosmolar tears
- Increased total tear protein, secretory IgA and albumin
- Reduced epithelial adhesion is found following contact lens wear. This appears to be directly related to the reduced number of hemidesmosomes

36. Ans. (a) Pseudomonas

Ref: Yanoff 4/e, p. 217

Although disruption of the continuity of the epithelium is the most common event that allows the establishment of a corneal infection, a few organisms such as Corynebacterium diphtheria, jaemophilus aegypticus, Neisseria gonorrhoeae, Neisseria meningitides and Shigella and Listeria species can penetrate an intact epithelium.

37. Ans. (a) Pseudomonas

Ref: Khurana 6/e, p. 102

- "Pseudomonas ulcers are usually associated with hypopyon, spread very rapidly & may even perforate within 48-72 hrs.
- Pseudomonas is the most common gram negative organism causing corneal ulcer.

38. Ans. (b) Olopatadine

Ref: Cornea by Mark J Mannis, 4/e, p. 245

Olopatadine is a dual action anti allergic and thus has no role in infective pathology.

- Steroid for corneal ulcer **(SCUT) Trial** evaluated the use of topical steroids in conjunction with topical antibiotics. It concluded that patients with severe ulcer may benefit
- **Potential advantages** include the suppression of inflammation which reduce the corneal scarring & visual loss
- **Potential disadvantages** include recrudescence of infection, local suppression of host defences, inhibition of collagen synthesis predisposing to corneal melting, increased IOP and cataract formation

- **Current evidence based recommendations**
  If corneal infiltrate compromises the visual axis, start topical corticosteroid theropy atleast 2-3 days after improvement with antibiotics

39. Ans. (c) Sclerokeratitis

Ref: Cornea, Table 78.1, p. 944

Sclerokeratitis is the least common type of ocular involvement in HZO

Corneal changes in HZO

Morphology/pathogenesis	Frequency (%)	Usual onset
Punctate epithelial keratitis	50	2 days
Pseudodendritic keratitis	50	4–6 days
Anterior stromal keratitis	34	7 days
Serpiginous ulceration	7	1 month
Sclerokeratitis	1	1 month
Corneal mucus phoques	13	2–3 months
Disciform keratitis	10	3–4 months
Neurotrophic keratopathy	25	2 months
Exposure keratopathy	11	2–3 months
Intonsition keratitis lipid keratopathy	15	1–2 years
Permanent corneal edema	5	1–2 years

40. Ans. (b) Acanthomoeba keratitis

Ref: Kanski 7/e, p. 197; Yanoff 3/e, p. 274-275, 338; Parson's 21/e, p. 203.

The presence of paracentral ring shaped corneal infiltrates in association with use of contact lenses and absence of response to standard treatment strongly suggests a diagnosis of Acanthomoeba keratitis.

41. Ans. (b) Fusarium species

Ref: Parson's 21/e, p. 199; Kanski 7/e, p. 180-181; Yanoff 3/e, p. 271

History of trauma to eye involving vegetative matter and corneal infiltrate with feathery/fluffy margins is typically of fungal keratitis (Fusarium).

42. Ans. (d) Ability of Pseudomonas to produce biofilms

Ref: Cornea by Krachmer, Holland and Mannis

Antibiotic resistance to Pseudomonas Aeroginosa strains from contact lens wearer largely results from the ability of these strains to from 'slime enclosed microcolonies' or biofilms. Biofilms grown cells show increased resistance to biocides and antibiotics through multiple resistance mechanism.

43. Ans. All are correct

Ref: Parson's 22/e, p. 205-07; Kanski 7/e, p. 183

- ***Ring infiltrates**, central or paracentral, with overlying epithelial defects & underlying keratic precipitate" are characteristic in acanthamoeba keratitis.*

Differential diagnosis of Corneal ring infiltrates

- Acanthamoeba
- Aspergillus
- Anaesthetic abuse (Proparacaine)
- Acute Myeloid leukemia
- Behcet disease
- Bacillus cereus
- Contact lens use
- Pseudomonas
- Viruses including HSV,VZV,EBV produce immunologically mediated corneal infiltrates that may resemble a bacterial, fungal or Acanthamoebic keratitis – Cornea 4th/880
- ***"Dendritic ulcer base stains with fluorescein & the margins with rose Bengal".***

44. Ans. (e) Hypopyon ulcer

Ref: Parson's 20/e, p. 196-97

- Phlyctenular keratitis – it is a result of a presumed delayed hypersensitivity reaction to staphylococcal antigen or tubucloprotein
- Rosacea – uncertain etiology
- Marginal ulcer – caused by a hypersensitivity reaction against staphylococcal exotoxins and cell wall proteins with deposition of antigen-antibosy complexes in the peripheral cornea. The lesions are culture negative.

Differentiation between HSV marginal keratitis and staphylococcal marginal keratitis

Characteristics	HSV marginal keratitis	Staphylococcal marginal keratitis
Etiology	Infective	Immunologic
Epithelial defect	Present	Generally absent, may occur late in the course
Progression	Centrally	Circumferentially
Limbal injection	More	Minimal
Lucid interval between limbus and ulcer	Absent	Present
Neovascularization	Present	Absent
Blepharitis	Absent	Present
Location	Any meridian	Generally 2, 4 8 10 O' clock

- Mooren ulcer (Rodent ulcer or chronic serpiginous ulcer) – thought to have an autoimmune mechanism

45. Ans. (b) Acanthamoeba

Ref: Yanoff 4/e, p. 246

Infections

- Congenital/acquired syphilis
- Lyme disease
- *Chlamydia*
- Viral keratitis

Vasculitis

- Wegener's granulomatosis
- Polyarteritis nodosa

Collagen Vascular Disease

- Rheumatoid arthritis
- Relapsing polychondritis
- Sarcoidosis

46. Ans. (b) Can occur as opportunistic…; (c) Can be cultured on non-nutrient…; (d) Painful condition; (e) Radial kerato-neuritis…

Ref: Khurana 6/e, p. 112-14; Parson's 22/e, p. 208; Harrison's 19/e, p. 1367-68

- Acanthamoebic keratitis can be a devastating infection if not recognized early. Its occurrence is frequently associated with the wearing of ***soft contact lenses.***
- ***Ocular pain is severe***, perhaps due to deep linear stromal infiltrates localized along the ***corneal nerves***
- ***Contact lens wearers*** using home-made saline (from contaminated tap water and saline tablets) is the commonest situation recognised for acanthamoeba infection in western countries.
- Acanthamoeba keratitis can also occur as opportunistic infection in patients with herpetic keratitis, bacterial keratitis, bullous keratopathy and neuroparalytic keratitis.

47. Ans. (a) Aspergillus spp.

Ref: Kanski 7/e, p. 180-181

Feathery margins with hypopyon is indicative of a fungal ulcer and the most common cause for it is Aspergillus.

48. Ans. (a) Nocardia asteroids

Ref: Cornea by Mannis, 4/e, p. 883

Nocardia ulcer can present with satellite lesions and is associated with trauma – thus can mimick Fungal corneal ulcer.

49. Ans. (c) Symptoms are more pronounced than signs

Ref: Parson's 20/e, p. 192

Signs are more pronounced than symptoms in fungal corneal ulcer.

50. Ans. (c) Macular dystrophy

Ref: Kanski 7/e, p. 220-221

"Macular dystrophy is an autosomal recessive dystrophy" with gene locus at 16q 22

51. Ans. (b) Primarily bilateral

Ref: Yanoff 4/e, p. 256

"A corneal dystrophy is classically bilateral, progressive, and isolated to the cornea. The disorder is inherited, characteristically in a dominant fashion, and often appears clinically to involve only one layer of the cornea".

52. Ans. (a) Macular Dystrophy

Ref: Kanski 7/e, p. 220

Macular Dystrophy is the least common corneal stromal dystrophy.

53. Ans. (d) Masson trichrome

Ref: Kanski 7/e, p. 218

Histopathology of Granular corneal dystrophy shows hyaline deposits beneath the epithelium and in the stroma. These deposits stain bright red with Masson Trichrome stain and stain weakly with PAS.

54. Ans. (a) Band kerotopathy

Sarcoidosis is associated the band keratopathy from metabolic derangement resulting in hypercalcemia and from chronic uveitis.

55. Ans. (e) Behind...

Ref: Khurana 4/e, p. 127; Parson's 20/e, p. 210

56. Ans. (d) Neural Crest

Ref: Yanoff 3/e, p. 203

Refer Text

57. Ans. (b) Cornea

Ref: Cornea by Mannis, 4/e, p. 897

Seen in a number of corneal pathologies like Fuch dystrophy, PPMD, Scheie syndrome, etc.

58. Ans. (c) Calcium

Ref: Yanoff 4/e, p. 270; Parson's 21/e, p. 209-210

59. Ans. (c) Urrets-Zavalia syndrome

Ref: Kanski 7/e, p. 242; Cornea by Mannis, 4/e, p. 1369

60. Ans. (c) 30–40%

Ref: Cornea: July 2007- Volume 26-Issue 6 p. 670-674)

Reported mean endothelial cell loss (usually at 6 months post op) varies from 24-59% (with standard deviations) across the studies.

61. Ans. (d) Blanching of vessels with 10% phenylephrine

Ref: http://www.aios.org/cme/cmeseries29.pdf

Feature	Episcleritis	Scleritis
Presenting	Redness, irritation are the main presenting symptoms	Severe excruciating pain is the main symptoms (Deterriorates at night and often wakes up the patient from sleep)
Tenderness	Nil or minimal tenderness	Moderate to severe tenderness
Clinical Sign (Congestion)	Congested vessels are bright red in color and vessels can be easily with the help of cotton bud	Congested vessels are purple red in color and vessels cannot be moved easily with cotton bud
Blanching	Blanching of vessels occurs with 10% phenylephrine	Blanching of vessels does not occurs with 10% phenylephrine

62. Ans. (c) Specular microscopy analysis is used to assess endothelial cell count

Ref: Textbook of Ophthalmology by Sunita Agarwal (Jaypee) 1st

- Corneoscleral button needs to be preserved, though whole eye can also be preserved.
- Age is not a criteria for donor eye.
- HLA matching is not mandatory as the cornea is immunologicaly previliged.

63. Ans. (d) Mucopolysaccharidosis

Ref: Parson's 22/e, p. 221

Causes of neonatal corneal opacification —MCG-SRT

- **M**ucopolysaccharidosis
- **C**ongenital hereditary endothelial dystrophy-type -I
- **G**laucoma (congenital)
- **S**clerocornea
- **R**ubella
- **T**trauma (Birth trauma)

"**Mucopolysaccharidoses (MPS)** can manifest with corneal clouding, including *Hurler, Scheie, and Hurler-Scheie syndromes (all MPS I); Morquio syndrome (MPS IV); and Maroteaux-Lamy syndrome (MPS VI).*

Corneal clouding is not present in Hunter syndrome (MPS II) and Sanfilippo syndrome (MPS III)" *(emedicine.medscape.com)*

64. Ans. (a) Deposition...; (c) Found in Wilson...; (d) Deposition under...

Ref: Khurana 6/e, p. 434; Parson's 22/e, p. 220

"**Kayser-Fleischer ring:** It is a golden brown ring which occurs due to ***deposition of copper*** under peripheral parts of the Descemet's membrane of the cornea".

65. Ans. (a) Fatty...; (c) Deposition...

Ref: Khurana 5/e, p. 117, 90; Parson's 20/e, p. 201

66. Ans. (a) Marfan syndrome; (b) Ehler-Danlos syndrome; (d) Down syndrome

Ref: Kanski 7/e, p. 210

Associations

1. **Systemic** disorders include **Down**, 'Turner, **Ehlers**-Danlos and **Marfan** syndromes, **atopy**, **osteogenesis** imperfecta, **mitral valve** prolapse and **mental retardation**.
2. **Ocular** associations include **vernal keratoconjunctivitis**, blue sclera, aniridia, ectopia lentis, Leber congenital amaurosis, retinitis pigmentosa and persistent eye rubbing.

67. Ans. (a) Stop the drug

Ref: Parson's 20/e, p. 206; American Academy of Ophthalmologist: Cornea Section 8, p. 2009-2010/375; Cornea by Krachner 2/e, p. 365-69; Kanski 6/e, p. 321

Refer Bonus page

68. Ans. (b) Padding..), (c) Cold.., (d) lubricant.. (e) Analgesics

Ref: Parson's 20/e, p. 205-206

- Caused by UV rays – industrial welding, short circuit bright flash, cinema studios
- Due to desquamation of epithelium leading to multiple erosions
- Latent period of 4 to 5 hours between exposure and onset
- Prevented by wearing dark glasses
- Treatment – cold compresses, lubricant eye drops, bandaging for 24 hours

69. Ans. (a) Can be associated with SLE; (b) Take longer time to resolve...; (c) More symptomatic...; (e)Elevated hard nodule

Ref: Smolin & Thoft 4/e, p. 531, Kanski 7/e, p. 252

- Nodular episcleritis tends to be more symptomatic & has a prolonged course
- Chemosis recurrent episcleritis or scleritis may be the initial presenting manifestations in SLE.

70. Ans. (b) Does not occur in Ehlers-Danlos syndrome

Ref: Kanski 7/e, p. 262

Blue discolouration of sclera is caused by thinning or transparency of scleral collagen with visualization of the underlying Uvea.

71. Ans. (a) Ferry's Line-corneal epithelial iron line...; (b) Stockers Line-Corneal epithelial...; (e) Coat's white ring- A form of iron ...

Ref: Yanoff & Duker/4/e, p. 271

Refer bonus page (pg. 487)

72. Ans. (d) SSPE

Ref: npcb.nic.in

- **Contraindications for Retrieval:**
  - Active viral Hepatitis
  - Acquired immunodeficiency syndrome (AIDS) of HIV
  - Active viral encephalitis or encephalitis of unknown origin
  - Creutzfeldt-Jakob disease
  - Rabies
- **Conditions with potential risk of transmission of local or systemic communicable from donor to recipient**
  - Death of unknown cause*
  - Death with neurologic disease of unestablished diagnosis*
  - Subacute sclerosing panencephalitis
  - Progressive multifocal leukoencephalopathy
  - Active meningitis or encephalitis*
  - Encephalopathy of unknown origin or progressive encephalopathy*
  - Active septicemia* (bacteremia, fungemia, viremia, parasitemia
  - Active viral hepatitis*
  - Creutzfeldt-Jakob disease*
  - Congenital rubella
  - Reye's Syndrome
  - Rabies*
  - Active miliary tuberculosis or tubercular meningitis*
  - Patients on ventilator for > 72 hrs
  - Hepatitis B surface antigen positive donors*
  - HTLV-I or HTLV-II infection*
  - Hepatitis C Seropositive donors*
  - HIV seropositive donors*
  - HIV or high risk for HIV corneas

(All conditions marked with an asterisk sign are Absolute contraindiactions)
As can be clearly read in the above information SSPE is not an absolute contraindication.

73. Ans. (c) Neurofibromatosis

Ref. Kanski 8/e, p. 262, Basak Samar K, p. 366

Causes of Blue Sclera are:
- In premature babies
- Osteogenesis imperfect (Type I & Type IIA)
- Buphthalmos – congenital glaucoma
- High myopia
- Ciliary staphyloma
- Marshall-Smith syndrome
- Russell-Silver syndrome
- Hallermann-Streiff-Francois syndrome
- Pseudoxanthoma elasticum

Blue Sclera

- Ehler danlos syndrome Type VI
- Marfan's syndrome
- Oculodermal melanocytosis
- Diffuse scleritis

74. Ans. (c) Lack of inflammation

Ref: Kanski 7/e, p. 257

Seleromalacia perforans is a necrotizing scleritis without inflammation affecting elderly women with long-standing rheumatoid arthritis.

No pain, no loss of vision and no vascular congestion.

75. Ans. (d) Increased corneal diameter

Ref: Kanski 7/e, p. 212

- Cornea becomes globular rather than conical
- Entire cornea is abnormally thin – generalized rather than at apex.
- May be associated with blue sclera and Leber congenital amaurosis.
- Acute hydrops occurs less commonly.
- But more prone to rupture.
- Corneal diameter is normal.

(All the above signs help to differentiate Keratoglobus from Keratoconus)

76. Ans. (a) Au

Ref: Ocular Pathology E Book: Expert Consult

- It is performed by chemical reduction of metallic salts (eg. gold cholride or platinum black)
- Histologically, the foreign material is seen in the corneal stroma

77. Ans. (c) Erosion of epithelium with underlying inflammation

Ref: Khurana 6/e, p. 98

Corneal ulcer may be defined as discontinuation in normal epithelial surface of cornea associated with necrosis of the surrounding tissue

78. Ans. (a) Satellite lesions; (b) Wesseley immune ring; (e) Feathery margins

Ref: Corneal ulcers diagnosis and management, Namrata Sharma/80, Parson's 20/e, p. 192-193

Mobile and sterile hypopyon – Bacterial corneal ulcer
Immobile (thick) and asterile hypopyon – Fungal Corneal ulcer

79. Ans. (a) Retinitis...; (b) Behçet's disease; (d) Fungal corneal ulcer

Behcet disease caused Mobile hypopyon
Best's diseases presents with Pseudo-hypopyon (which is collection of white deposit other than pus in AC)
Fungal corneal ulcer cause, immobile and asterile hypopyon
Hypopyon can also be seen in cases of endophthalmitis, infective severe Iridocyclitis

80. Ans. (a) Atropine eye drops

Ref: Kanski 7/e, p. 179; Khurana 6/e, p. 104

Cycloplegic – 1% atropine eye drops or ointment are used to
- Reduce pain from ciliary spasm
- Prevent formation of posterior synechiae
- Increase blood supply to uvea

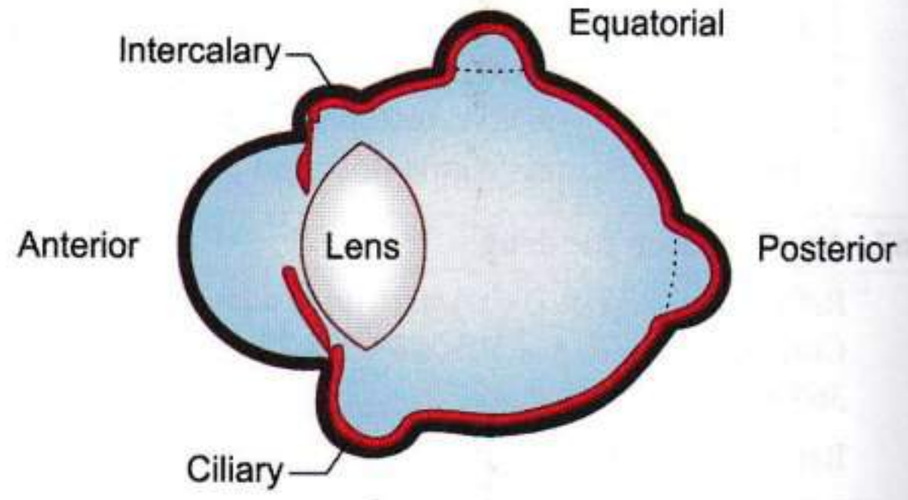
Reduce exudation and hyperemia

81. Ans. (b) Staphyloma

Ref: Khurana 6/e, p. 144-145

Option a – Corneal dystrophies donot present with bulging
Option c – Keratomalacia occurs due to deficiency of vitamin A (X3B)
Option d – Keratoconus doesnot have any co-relation to glaucoma. It is cone shaped cornea

Option b – Staphylomas refer to localized **bulging** of weak and thin outer tunic of eyeball (cornea or sclera)



Anterior – an ectasia of the pseudocornea with iris plastered behind it
Intercalary – bulging in limbal area lined by root of iris. Occurs following a **healed perforation** or **untreated Secondary angle closure glaucoma**
Ciliary – bulging of **sclera 2-3mm posterior to limbus** lined by ciliary body. Occurs following **scleritis and absolute (end stage) glaucoma**
Equatorial – bulging of sclera lined by choroid
Posterior – bulging of sclera lined by choroid posterior to equator. Occurs in pathological myopia

82. Ans. (a) Atropine eye drops

Ref: Kanski 7/e, p. 179; Khurana 6/e, p. 104

Cycloplegic – 1% atropine eye drops or ointment are used to
- Reduce pain from ciliary spasm
- Prevent formation of posterior synechiae
- Increase blood supply to uvea
- Reduce exudation and hyperemia

83. Ans. (a) Aspergillus

Ref: Parson's 22/e, p. 201

84. Ans. (c) Mid-periphery

Ref: Parson's 22/e, p. 216; Cornea by Jay H. Krachmer 4/e, p. 866)

The thinning in Keratoconus is central or paracentral (Inferior)

NOTES

14

COMMUNITY OPHTHALMOLOGY

NATIONAL PROGRAMME FOR CONTROL OF BLINDNESS AND VISUAL IMPAIRMENT

This is the new nomenclature for the previously named National Programme for control of blindness (NPCB)

Definition

The definition of Blindness under the National Programme for Control of Blindness (NPCB) is hereby modified in line with WHO Definition

- *Presenting distance visually acuity* ***less then 3/60****(20/400) in the better eye*
- *Limitation of field of vision to be* ***less than 10 degrees*** *from center of fixation*

WHO definition	Best corrected Visual acuity in better eye
Normal vision	≥6/18
Low vision	<6/18 to >3/60
Blindness	<3/60

WHO definition of blindness

- BCVA in the better better eye **<3/60**, which means inability to count fingers under good illumination at 3 meters
  OR
- Visual field **less than 10 degrees** in the better eye

Strategies

Strategies of National Programme for Control of Blindness (NPCB, 1976)

- Strengthening service delivery
- Developing human resources for eye care
- Promoting outreach activities and public awareness
- Developing institutional capacity
- To establish eye care facilities for every 5 lac persons

Revised Strategies of NPCB[Q]

- *To make NPCB more comprehensive by:*
  - Strengthening services for other cause of blindness like corneal blindness and refractive errors in school children
  - Improving follow-up service of cataract operated persons
  - Treating other causes of blindness like glaucoma
- To strengthen participation of voluntary organizations
- To shift from eye camp approach to fixed facility surgical approach[Q]
- To enhance coverage of eye services in tribal & underserved areas
- To expand World Bank project activities:
  - Construction of dedicated eye OTs and eye wards
  - Training of eye surgeons
  - Modern cataract surgery
  - Supply of ophthalmic equipment

Goals and Objectives - XII Plan

- To reduce the backlog of blindness through identification and treatment of blind at primary, secondary and tertiary levels based on assessment of the overall burden of visual impairment in the country.
- Develop and strengthen the strategy of NPCB for "Eye Health" and prevention of visual impairment; through provision of comprehensive eye care services and quality service delivery.
- Strengthening and upgradation of RIOs to become centre of excellence in various sub-specialities of ophthalmology
- Strengthening the existing and developing additional human resources and infrastructure facilities for providing high quality comprehensive Eye Care in all Districts of the country;
- To enhance community awareness on eye care and lay stress on preventive measures;
- Increase and expand research for prevention of blindness and visual impairment
- To secure participation of Voluntary Organizations/Private Practitioners in eye Care

Blindness – Facts

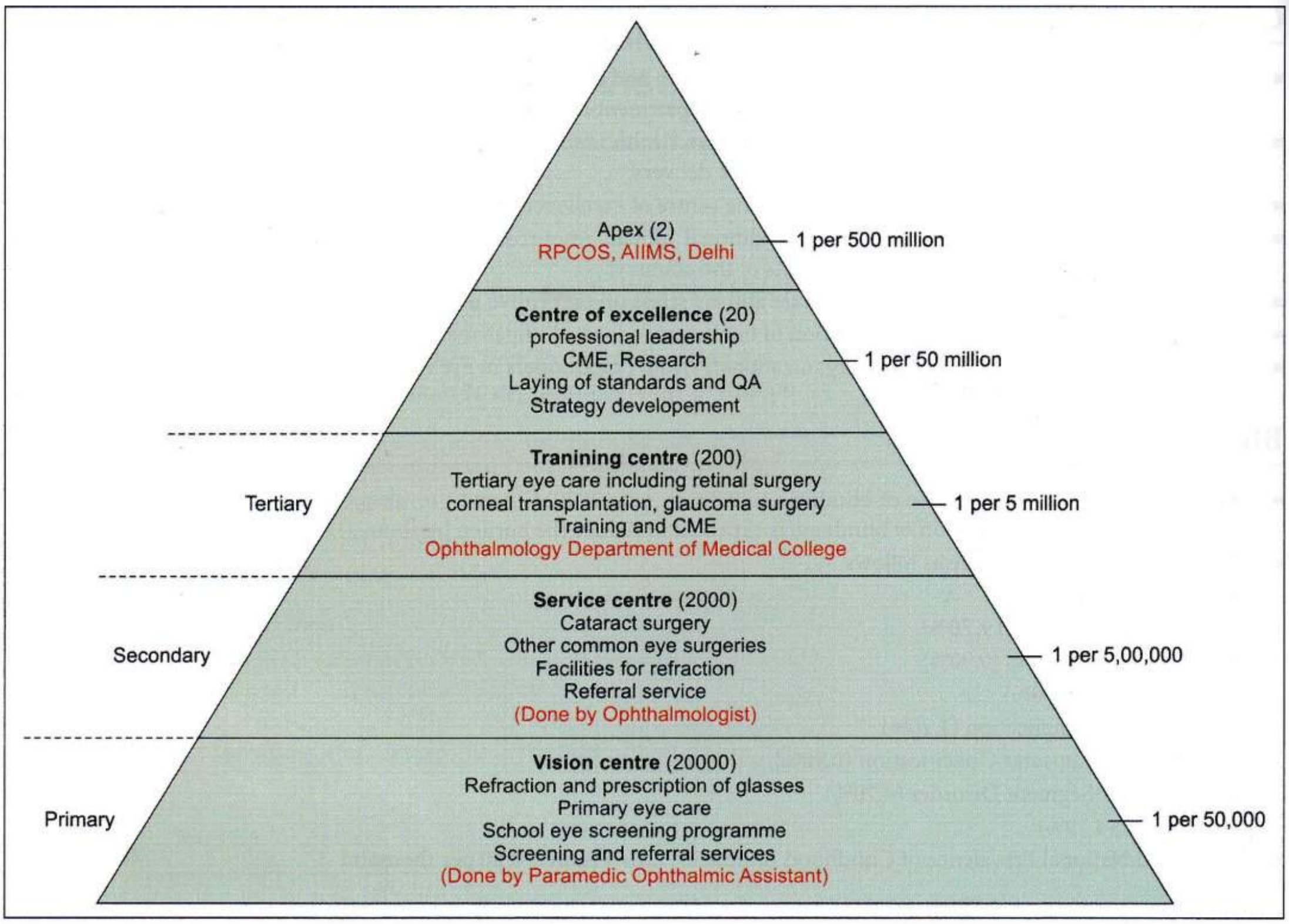
- **Goal** – to reduce the prevalence of blindness to 0.3% by year 2020. Current prevalence (according to older definition of NPCB) – 1.05% New definition of blindness is expected to reduce the burden by about 1/3rd
- Main causes of blindness are as follows
  - **Cataract (62.6%)**
  - **Refractive Error (19.70%)**
  - Corneal Blindness (0.90%)
  - Glaucoma (5.80%)
  - Surgical Complication (1.20%)
  - Posterior Capsular Opacification (0.90%)
  - Posterior Segment Disorder (4.70%)
  - Others (4.19%)
- Estimated National Prevalence of Childhood Blindness /Low Vision is 0.80 per thousand

VISION 2020

- **Aim:**
  - To reduce the blind people to 25 million by 2020
  - To eliminate avoidable (preventable bindness by 2020 and curable)

Launched by Geneva in 1999 to eliminate avoidable blindness.
The mission was launched in India in 2001 at Goa

Diseases covered under Vision 2020 – Globally ⑤		Diseases covered under Vision 2020 – India ⑦	
• Cataract • Refractive errors • Childhood blindness	• Trachoma • Onchocerciasis	• Cataract • Refractive errors • Childhood blindness • **Corneal blindness**	• Trachoma • **Glaucoma** • **Diabetic retinopathy**



Basic strategies:

- Disease prevention and control
- Training of personal
- Strengthening the existing eye care infrastructure
- Use of appropriate and affordable technology
- Mobilization of resource

School Eye Screening Programme

- Focus on middle school (**V – VIII class**) covering **10–14 years age**[Q]
  - 150,000 children to be screened per block
- **One trained teacher to handle 150 students**[Q]
  - 1–day training for teacher at nearest PHC[Q]
  - Teacher Kit: Vision screening cards, referral cards, tape/rope to measure 20 feet
- ***Visual cut-off for referral to nearest PHC:* <6/9 in either eye**[Q]
- *Prerequisites for undertaking SES:*
  - Para-medical Ophthalmic Assistant (**PMOA**) available[Q] at nearby PHC
  - Relevant equipment procured
  - Optician contracted for providing spectacles

MULTIPLE CHOICE QUESTIONS

1. The WHO definition of low vision in children *(All India 2008)*

a. Visual acuity 6/60 to 3/60 in better eye with best correction
b. Visual acuity 3/60 to 6/60 in better eye with best correction
c. Visual acuity 6/18 to 6/60 in better eye with best correction
d. Visual acuity <3/60 in better eye with best available correction

2. What is the WHO criteria for defining blindness?

a. < 3/60 vision with available correction *(PGI Nov 2016)*
b. < 6/60 vision with available correction
c. < 3/60 vision with best correction
d. <6/60 vision with best correction
e. <3/60 vision without correction

3. Which of the following is not a criteria for blindness according to NPCB? *(AIIMS Nov 2016)*

a. Vision 6/60 or less with least possible spectacle correction in the better eye
b. Vision <4/60 in the better eye
c. Inability of person to count fingers from distance of 20 feet or 6 meter
d. Diminution of field vision to 20 degrees

4. True about component of vision 2020 *(PGI Nov 2016)*

a. Cataract surgery should be performed at primary level
b. Retinal surgery should be performed at tertiary level
c. Need to develop 10 centre of excellence at tertiary level and 100 training centre at advanced tertiary level
d. Ophthalmia neonatorum is included in childhood blindness
e. Primary vision center covers a population of 50000

5. The most common cause of ocular morbidity in India is *(All India 2008)*

a. Cataract
b. Refractive error
c. Conjunctivitis
d. Trachoma

6. According to WHO, the most common cause of preventable blindness in India? *(NIMHANS 2016)*

a. Keratomalacia
b. Cataract
c. Refractive error
d. Glaucoma

7. Most common cause of blindness in india is? *(Recent pattern Nov/Dec 2016)*

a. Aphakia
b. Glaucoma
c. Refractory error
d. Cataract

8. Which of the following is output indicator for NPCB? *(AIIMS Nov 2014)*

a. Number of cataract surgeries leading to sight restoration
b. Decrease in prevalence of blindness
c. Number school children provided glasses for efraction correction
d. Number of eye surgeons trained

9. Which of the following is called eye donation fortnight? *(Recent pattern 2014)*

a. July 25 to august 8
b. August 25 to September 8
c. September 25 to October 8
d. October 25 to November 8

10. Which agency is not a partner of Vision 2020?

a. WHO
b. UNESCO
c. IAPB
d. ORBIS International

11. If blind school surveys are used for estimation of total blindness in India, it will lead to *(AIIMS)*

a. Gross overestimation
b. Gross underestimation
c. Correct estimation
d. Cannot be predicted

ANSWERS TO MULTIPLE CHOICE QUESTIONS

1. Ans. (c) Visual acuity 6/18 to 6/60 in better eye with best correction

Ref: Parsons 20th/523

2. Ans. (c) < 3/60 vision with best correction

Ref: www.who.int

3. Ans. (c) Inability of person to count fingers from distance of 20 feet or 6 meter

Ref: www.npcb.nic.in

Vision <4/60 comes under the definition of Economic blindness.

NPCB (National program for control of blindness)

NPCB definition	Best corrected visual acuity in the better eye
Normal vision	≥6/18
Low vision	<6/18 to ≥6/60
Economic blindness	<6/60 to ≥3/60
Social blindness	<3/60 to ≥1/60
Manifest blindness	<1/60 to perception of light
Absolute blindness	No perception of light

NPCB definition of blindness (old guildelines)

- BCVA in the better eye less than 6/60 which means the inability to count fingers under good illumination at 3 meters
  Or
- Visual field less than 20 degree in the better eye

National Programme for Control of Blindness was launched in the year 1976 as a 100% Centrally Sponsored scheme with the goal to reduce the prevalence of blindness from 1.4% to 0.3%. As per Survey in 2001-02, prevalence of blindness is estimated to be 1.1%. Rapid Survey on Avoidable Blindness conducted under NPCB during 2006-07 showed reduction in the prevalence of blindness from 1.1% (2001-02) to 1% (2006-07). Various activities/initiatives undertaken during the Five Year Plans under NPCB are targeted towards achieving the goal of reducing the prevalence of blindness to 0.3% by the year 2020.

4. Ans. (b) Retinal surgery should be ..., (d) Ophthalmia neonatorum..., (e) Primary vision center...

Ref: Khurana 6th/480-82; Parson 22nd/566-71]

5. Ans. (b) Refractive error

Ref: Pradeep Sharma 1st 338, 339, 340

The most common ocular condition causing morbidity is low vision.
Refractive errors are the most common cause of low vision (Ocular Morbidity).

6. Ans. (b) Cataract

Ref: Park 23/e, p 401

7. Ans. (d) Cataract

Ref. Khurana 4/e, p 444

(npcb.nic.in)
"Most common cause of blindness in india according to national survey on blindness of 2006-2007 is cataract" (62.6%)

8. Ans. (a) Number of cataract surgeries leading to sight restoration

Ref: www.npcb.in

9. Ans. (b) August 25 to September 8

Ref. Education of communicable and non-communicable diseases by S.L. Goel p 158

10. Ans. (b) UNESCO

Partners of Vision 2020

- International agency for prevention of blindness (IAPB)
- Christoffel-Blinden mission
- ORBIS
- Sightsavers international
- Helen Keller international
- WHO

11. Ans. (b) Gross underestimation

As cataract is mostly seen in older age patients and is the most common cause of blindness in India, school surveys will not be able to estimate the correct burden.

BONUS PAGE 9

OCULAR SIDE EFFECTS OF DRUGS

- **Vortex keratopathy, or corneal verticillata**, is a common side effect of a number of systemic medications—e.g.
  - Amiodarone
  - Quinolones
  - Indomethacin
  - Tamoxifen
  - Atovaquone
  - Tilorone

  —and results from the intralysosomal accumulation of lipids. This condition presents with golden-brown deposits in a whorl-like pattern (arborizing horizontal lines) normally seen in the inferior corneal epithelium. This configuration is a result of the corneal epithelium's growth and repair process.

  Patients who present with this finding are typically asymptomatic, though they may report photophobia or halos around lights.
- White punctuate opacities in cornea – Amantadine
- Grey-blue scleral pigmentation – Minocycline (irreversible, starts at Limbus)
- **Angle closure Glaucoma**
  - Loratidine and Fexofenadine (Anti-allergic drugs)
  - Topiramate (Anti-epileptic) – due to uveal effusion/ciliary edema leading to forward displacement of the lens-iris diaphragm
- **Bull's Eye Maculopathy**

  Anti-malarials – Hydroxychloroquine and Chloroquine – B/L and irreversible
- **Macular edema**
  - Latanoprost
  - Epinephrine in aphakics
  - Niacin
  - Rosiglitazone
  - OCPs
  - Nicotinic acid
- **Uveitis**
  - Metipranolol – topical
  - Latanoprost (PGF 2 alpha analogues) – topical
  - Rifabutin
  - Terbinafine
  - Trimethoprim
  - Pilocarpine – topical
  - Bisphosphonates
  - Diethylcarbamazine
  - Oral contraceptive pills
  - Cidofovir
  - Urokinase
- Anterior subcapsular lens deposits
  - Amiodarone
  - Phenothiazine

- Allopurinol
- Chloroquine
- Busulfan
- Chlorpromazine

- Cataract
  - Steroids – initially posterior subcapsular cataract followed by anterior subcapsular cataract
  - Desfferioxamine
  - Allopurinol
- Red tears – Rifampicin
- Diplopia (idiopathic and idiosyncratic)
  - Glitazone
  - Ethambutol
  - Steroids
  - Topiramate
  - Fluroquinolone (all 5 systemic administration)
- Floppy Iris syndrome (intraoperative) – Tamsulosin
- Pseudotumour Cerebri – Hypervitaminosis A – leads to papilledema
- Interferon Retinopathy – Interferon alpha
  - 2 weeks – 3 months
  - Cotton wool spots and hemorrhages near optic disc
  - Associated with RVO/RAO/CME
  - Treatment – resolve sponataneously or treat coexisiting hypertension or discontinue drug
- Increased risk of Retinal detachment – oral Flouroquinolones
- Visual field defects
  - Vigabatrin – Visual field defects start a few years to months after starting the drug and range from a localized nasal defect of 30° to 40° in eccentricity and may extend to complete concentric contraction. The primary retinal effects are peripheral atrophy and nerve fibre bundle defects
  - Ethambutol – visual field defects are of two types
    - Central – central or centrocecal scotoma with blue-yellow color blindness
    - Peripheral – peripheral constriction with red-green colour loss
- Pseudopemphigoid – topical beta blockers
- Macular crystals
  - Tamoxifen – fine, yellow crystalline deposits. Also optic neuritis can be seen
  - Canthaxanthin
  - Nitrofurnatoin
  - Methoxyflurane – calcium oxalate crystals

BONUS PAGE 10

VARIOUS LINES IN OPHTHALMOLOGY

Arlt's Line

Horizontal line of conjunctival scarring in sulcus subtarsalis of superior palpebral conjunctiva, seen in Trachoma.

Ehrlich-Turk Line

Vertical linear deposition of KPs in uveitis.

Ferry's Line

Corneal epithelial iron line at the edge of filtering blebs of glaucoma surgery.

Hudson-Stahli Line

Iron deposition line in the corneal epithelium, which commonly seen in the **junction between middle and lower-third cornea.**

Khodadoust Line

- Corneal graft endothelial rejection line composed of inflammatory cells.
- Khodadoust's line separates immunologically damaged endothelium - usually originating from neovascularization in the same area - from the unaffected endothelium. In the area of damage the endothelium is decompensated resulting in stromal and epithelial edema. Timely immuno-suppression can reverse this process.

Paton's Line

- Circumferential retinal folds in peripapillary region due to papilledema.
- Papilledema is defined as optic nerve head edema secondary to increased intracranial pressure. The main cause of optic nerve head swelling is blockage of the axoplasma transport and the blockage occurs at the lamina cribrosa.
- The optic nerve head can swell to the extent where it is extended forward into the vitreous as well as laterally. This lateral swelling causes the retina to buckle inward at the temporal aspect of the optic nerve head. The buckling is known as Paton's lines or folds.

Sampaolesi Line

- Wavy line of Increased pigmentation anterior to Schwalbe's line.
- Occurs in
  - Pseudoexfoliation syndrome
  - Pigment dispersion syndrome
  - Trauma
  - Iris melanoma

Scheie's Line or Zentmayer's Line

- Pigment on lens equator and posterior capsule in pigment dispersion syndrome.
- Peripheral pigmentation of the posterior lens capsule anterior to the junction between the anterior hyaloid face and the posterior lens capsule (ligamentum hyaloideo-capsulare of Wieger)
- "*Scheie's line*" is considered to be pathognomonic for pigment dispersion syndrome.

Schwalbe's Line

- Termination of Descemet's membrane.
- Line where corneal scleral meshwork terminates anteriorly. Delineates the outer limit of the corneal endothelium layer.

Stockers Line

Corneal epithelial iron line at the edge of pterygium.

White lines of Vogt

- Sheathed or sclerosed vessels seen in Lattice degeneration.
- Lattice degeneration of the retina is a fairly common degenerative disease of the peripheral retina characterized by the presence of lattice lines created by fibrosed blood vessels.
- Crisscrossing fine white lines that account for the name lattice degeneration are present in roughly only 10% of lesions and most likely represent hyalinized blood vessels.

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About the Author

Dr Utsav Bansal MBBS DO is one of the youngest teacher and author in the field of Medical Entrance Examinations. He is a renowned faculty in various Institutes and has been taking classes all over India. Since his MBBS days he has been an avid presenter of various papers in conferences, which have received awards and have been published in indexed journals. He approaches the subject by simplifying complex topics – breaking them in points, putting them in flow charts and diagrams, adding mnemonics, etc. His notes are highly appreciated by the students which motivated him to put it altogether in this book.

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